THE ARTIZAN:

A Monthly Record of the Progress

OF

CIVIL AND MECHANICAL ENGINEERING,

SHIPBUILDING, STEAM NAVIGATION, THE APPLICATION OF CHEMISTRY TO THE INDUSTRIAL ARTS, &c.

EDITED BY WM. SMITH, C.E.,

F.G.S., F.C.S., F.R.G.S., &c.

VOL. XIV.
NEW SERIES.

VOL. XX.
FROM THE COMMENCEMENT.

London:
PUBLISHED AT THE OFFICE OF THE "ARTIZAN" JOURNAL,
19, SALISBURY STREET, STRAND, W.C.

1862.

LONDON:
PRINTED BY JAMES HENRY GABALL,
AT THE "SCIENTIFIC PRESS," No. 3, RUSSELL COURT, BRYDGES STREET, COVENT GARDEN, W.C.

ALEXAR CRICHTON, ENGINEER, CORK.

FIG.

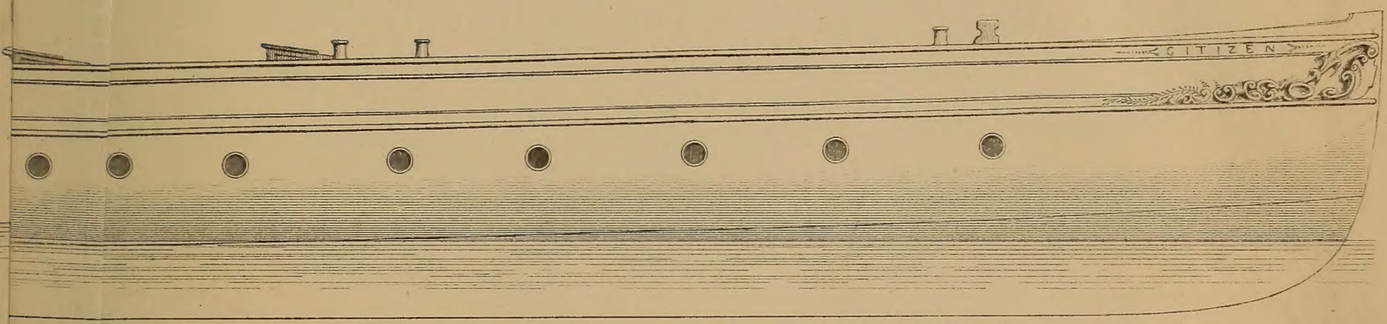
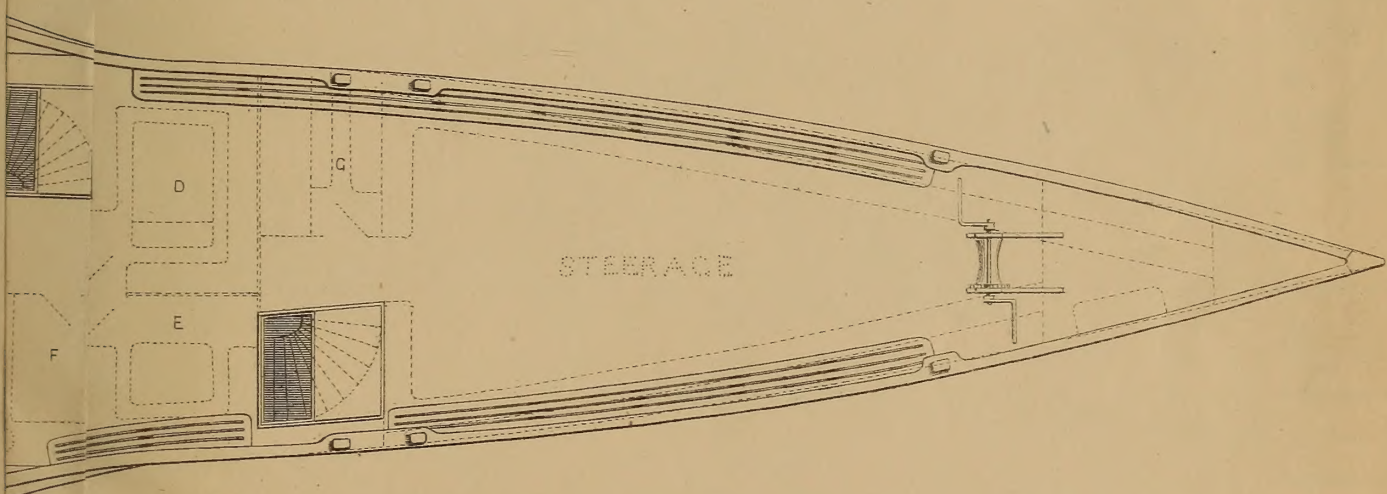


FIG. 2



REFERENCE

Length over all	165'. 0"
Breadth of Beam	17 . 6
Draught of Water	3 . 6

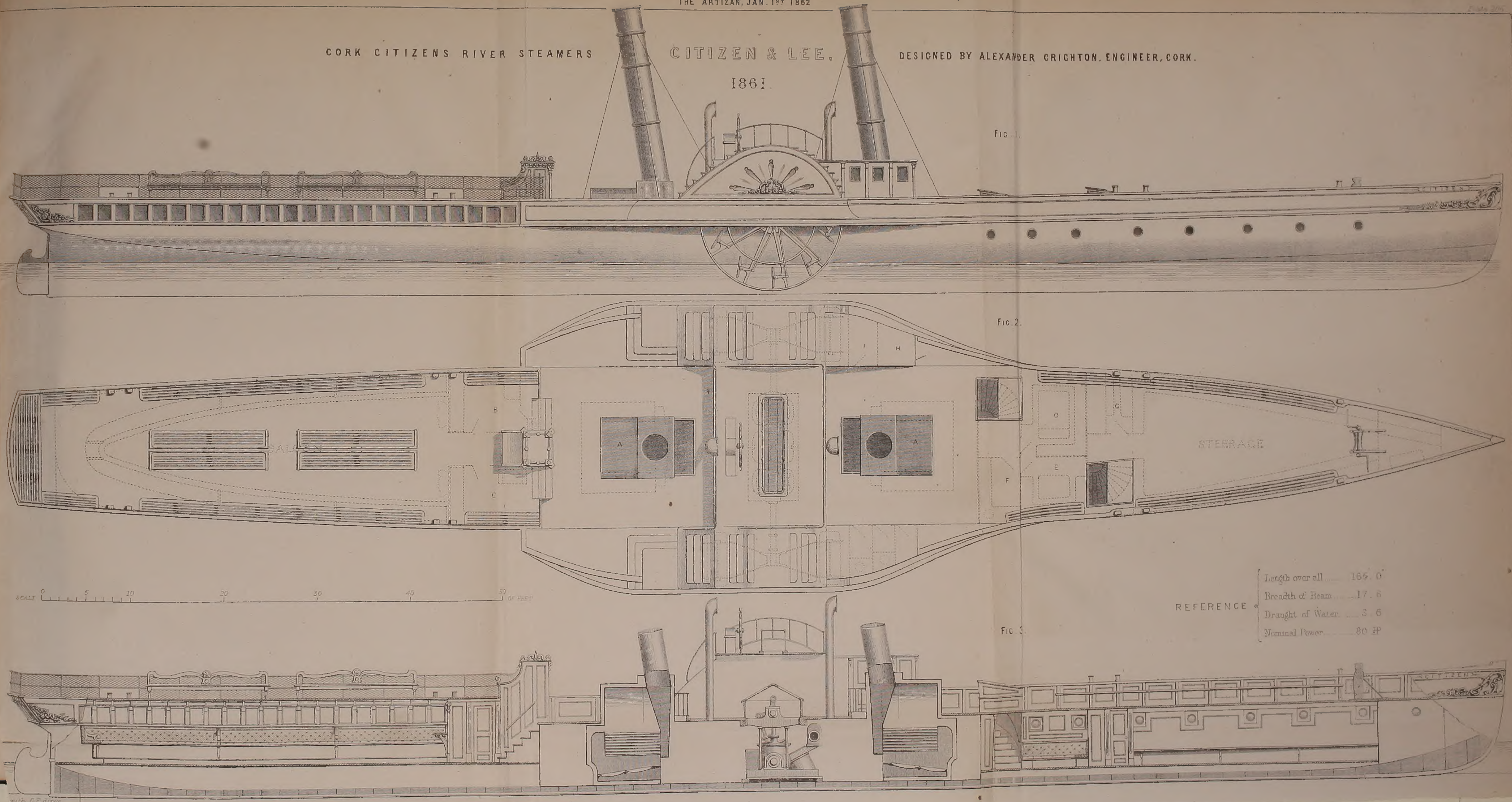
FIG. 3.

CORK CITIZENS RIVER STEAMERS

CITIZEN & LEE,

1861.

DESIGNED BY ALEXANDER CRICHTON, ENGINEER, CORK.



REFERENCE

Length over all	165. 0
Breadth of Beam	17. 6
Draught of Water	3. 6
Nominal Power	80 HP

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LIST OF PLATES.

TO THE BINDER.

Plate No. 224.—Incline tank engine for the Great Indian Peninsular Railway, Bombay, to face title-page.

THE ARTIZAN.

No. 229.—Vol. 20.—JANUARY 1, 1862.

"ARTIZAN" ADDRESS, 1862.

In continuing the practice introduced several years ago of editorially addressing our readers in the January number upon subjects affecting the interests of the Artizan, and personal to ourselves, and also briefly sketching the most important incidents of the year just closed, and adding a few passing allusions to the probabilities and anticipations as to the future. The present occasion, however, offers fewer opportunities than in former years for treating our usual subjects at any length.

We proceed, however, with our task by again tendering our best thanks to an extensive and still extending circle of friends and supporters for the material and much valued aid which they have afforded us during the year 1861, and to express a hope that they will continue to extend to us their valuable and, by us, highly esteemed countenance and support during the present year, and for years to come, indeed until "Time and the Artizan shall be no more."

Useful as we have been, our efforts in the same direction would be materially advanced, and the cause in which we are engaged greatly benefitted by the numbers of our subscribers increasing, and by their aiding in extending the introduction of the Artizan into every nook and corner amongst the civilised nations of the earth.

During the past year we have given a highly valuable series of plates, chiefly engraved on copper, and of the largest size that can be conveniently given with this journal. Some excellent illustrations of locomotive engines are included amongst the plates published. In May last we gave the concluding plate of the series of illustrations of the machinery of the *Great Eastern* steamship. With the September number we gave the concluding plate of the series illustrating Mr. Page's elegant new Bridge at Westminster, it being the fourth extra large plate devoted to that interesting subject. In the December number we devoted a plate to the elevation, plan, section, and detail of a Screw Pile Lighthouse erected by the American Government. Besides these several plates, a number of other large copper-plate engravings have been given, in illustration of various subjects, and, with one exception, they are either *illustrations of works executed*, or for the more thorough explanation of scientific papers contained in the body of the journal.

In addition to the plate illustrations, we published with the November number, a very large and expensive table, printed on both sides of the sheet, being a continuation of the table printed in the Artizan of March, 1859, giving very complete and official returns of the Results of Trials made in Her Majesty's Screw Ships and Vessels, by the Admiralty Officers up to July, 1861. This table has been exclusively published in the Artizan by permission of the Lords Commissioners of the Admiralty.

Amongst the original papers and contributions to our pages, will be found many, which for their practical value challenge comparison with any other scientific publication,—British or Foreign.

In the selection of papers read at the various Scientific institutions and societies, or extracted from various foreign contempories for publication in our pages, we have been guided by a desire to give place to those subjects most required by, and therefore most acceptable to, our readers.

That portion of our pages devoted in each number to a resumé of passing events worthy of record, given under the heading of "Notes and Novelties," having become more extended than formerly, has necessitated the omission of very many items of minor importance, whilst the extended and very complete selection has rendered it unnecessary for us to refer in our Annual Address to many of the topics upon which we previously felt it our duty to add a few remarks, as by a reference to our Notes and Novelties during the year, a very accurate idea may be gained of the progress made in those branches of Science, Arts, and Manufactures, to which the several headings refer.

During the year, the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Engineers in Scotland, the Institution of Naval Architects, the Society for the Encouragement of Arts, Manufactures, and Commerce,—The Royal Scottish Society of Arts, and other societies which address themselves to civil and mechanical engineering subjects, the industrial arts, and practical science, have each contributed numerous valuable papers, the most important of which will be found reported in our columns; and several of the younger institutions, such as the Society of Foremen Engineers, the Civil and Mechanical Engineers Society, and the Society of Engineers (the two latter societies being composed of pupils and junior members of the profession), have each held numerous meetings, at which many really valuable practical papers have been read and discussed; and we wish these younger societies the utmost success, of which they are very deserving. The British Association for the Advancement of Science, held its meeting last year in Manchester, under the able presidency of Mr. William Fairbairn, C.E., LL.D., F.R.S., &c. The meeting was the largest and most successful of those which had preceded it; but we missed many of the contributors to mechanical science who, during the last few years, have regularly attended the meetings of the Association; and the most noticeable features were the absence of papers upon the Economic Generation and Use of Steam, Surface Condensation, &c.; and this was the more remarkable, considering the great attention paid to these subjects by Dr Joule, of Manchester. Neither were there any contributions relative to the Working and Management of Railways; but several new committees were appointed by the Association, one of which was charged with the duty of reporting "On some of the causes of Railway Accidents," and which committee has since actively engaged in its duties, and has amongst its members such names as Fairbairn, McConnell, D. Gooch, Sturrock, Ramsbottom, M. Kirtley, R. Sinclair, J. H. Beattie, C. Markham, &c.; and several important series of experiments are about to be undertaken by them. The Committee on Steam Ship Performance was re-appointed, His Grace the Duke of Sutherland, Chairman. The next meeting of the British Association is to be held at Cambridge either in the month of June or September, and which, when arranged, will be duly announced.

Passing from a review of the labours of the various Scientific Institutions to one or two of the more important subjects which usually occupy our attention, and to which space is devoted by us in the pages of this journal—and indeed we cannot do more than select these few subjects and treat them but briefly—we have, foremost amongst them, to note the continued economic success of the development of the use of expansive engines for ocean steam navigation, and as an illustration of this continued and progressive success we have to point to the Pacific Mail Steamship *Peru*, which has just left Liverpool for Valparaiso, and which is the tenth ship belonging to the fleet of the Pacific Mail Company fitted with the improved machinery of Messrs. Randolph, Elder and Co. At the present time there are completed and working on board British steamships, about 7000 H.P. afloat, fitted with surface condensers. Of these, upwards of 3000 H.P. are fitted with the condensers patented by Mr. J.

F. Spencer, nearly 2000 H.P. are fitted with Sewell's condenser, and the remainder are made up of modifications of Hall's system, many of the latter being on what are known as Craddock's and Rowan's plans. In addition to the above-mentioned, upwards of 1500 H.P. are now being fitted with Spencer's condensers, several large engines with Sewell's condensers, and others on Hall's system, so that there is a total of 9000 nominal H.P. fitted and fitting with surface condensers at the present time. It must be borne in mind that excepting the *Alar*, fitted by Spencer in 1857, neither of the ships so fitted have been at work more than from two to three years, and by far the larger portion only during the shorter period.

There are several important questions connected with the introduction of surface condensation in Marine Engines, particularly in long voyage ocean steamers, and it appears they cannot be thoroughly solved, until the system has had a longer trial, and with more varied experience. Most of the instances of failure which have come to our knowledge have been from defects in construction, chiefly arising from the "cheap-Jack system" of manufacture and introduction being resorted to by the more avaricious and unscrupulous amongst the steamship owning class.

The advantages expected from the introduction of surface condsnsation, are principally increased durability of the boiler and a saving of fuel, by avoiding incrustation and also recourse to the wasteful system of blowing out a large percentage of the heated boiler water, to prevent an accumulation of injurious deposit in the boilers. There are also other incidental economic advantages to be expected from the proper introduction of the system.

By the result of experience to this date, there appears no doubt that the exclusive use of pure distilled water has in some cases had the discredit of producing an injurious effect on the boilers, and to meet the objection, recourse has been had to the use of sea water, for the purpose of making up the waste of pure water produced by the surface condenser and employed as feed-water. Now it has yet to be ascertained whether the erosive action, which is said to take place on the inner surfaces of marine boilers, is really due to the use of pure soft water, resulting from surface condensation, acting upon the brass and copper tubes, and producing a new combination or active principle to which the uncoated surface of the iron shell is subjected by galvanic agency, and if so, whether the presence of a proportion of salt water would counteract that action, in which case it would have to be determined what is the most suitable proportion of pure and impure water to protect the boiler, and at the same time to secure all the economy to be derived from clean boiler surfaces and the absence "blow-off," or, "scum discharge;" and, it would be well for the engineers of the numerous ships now fitted with surface condensers to accurately note, and carefully record all facts connected with the use of surface condensation.

As mentioned in our adress for 1860, the Admiralty ordered three pairs of 500 H.P. engines to be fitted in three sister ships for the purpose of testing competitively the machinery of Messrs. Randolph, Elder and Co., with the most economical machinery which Messrs. Penn and Son and Messrs. Maudslay and Co., could produce. Only one of those ships has yet been tried—that fitted by Messrs. Maudslay and Co.,—H.M. ship *Octavia*; a report of the trial of which has already appeared. The *Arethusa*, for which Messrs. Penn and Son have constructed the machinery, has not yet been fitted, and the machinery for the *Constance* has, we understand, been completed and ready for erection on board for several months past, and we hope that the completion and trial of these ships although so long deferred will not be further delayed, and that the trials will be conducted in a fair and thoroughly scientific manner, so that the results may enable that economy to be effected in the Royal Navy which has already been so successfully attained in our mercantile marine.

We believe Messrs. Penn and Son have adopted Spencer's condenser Messrs. Maudslay and Co., have adopted Hall's system; and Messrs. Randolph and Co., Sewell's condenser; it is therefore quite evident that surface condensation is now fairly on its trial, as we long ago urged it should be, and predicted it would be; and, whilst the advantages to be obtained by its employment were so important, it is to be hoped that any apparent objections or difficulties arising from its adoption will be overcome by the engineering talent now engaged in its practical application.

The conversion of the Naval authorities to a belief in iron as a material for building ships of war, is progessing most satisfactorily, as is evidenced by the increase in the number of iron war ships now in course of construction; but, the old fashioned notions about construction, which belong to the wooden era, must be abandoned, and something like scientific mechanical designing and proportioning of the strength of the various parts and the distribution and combination of the newer material, must be adopted before anything like the successful and economic construction of iron war ships can be hoped for. Admirable as the *Warrior* is, viewed as a piece of workmanship, and highly creditable as she is to the Thames Iron-works Company; and doubtless too, the *Black Prince* is equally creditable to Messrs. Napier and Sons,—what we pointed out in that part of our "Address" of 1861, which related to the same subject, has only the more forcibly been confirmed by a frequent inspection of the *Warrior*, and a further consideration of the subject. There is far too much labour involved in the present system of construction, and that labour of too costly a character. The quantities of material employed are in excess of what is requisite or necessary, from being injudiciously disposed. The system of building up, and combining the parts, is defective; and the mode of mounting and securing the armour plates is also injudicious, and of a non-permanent character, suited more for stationary or harbour defences, than for ocean-going war ships.

The Iron Plate Commission has conducted a series of practical experiments which, beyond determining the relative values of different thicknesses and qualities of materials arranged in various ways to resist shot, &c., has collected a vast deal of useful information, which is available for other purposes connected with practical science.

In Ocean Steam Navigation some material changes will probably be effected at a very early date, more particularly with reference to the proportions of depth and breadth to the length of steam ships, and the arrangement and disposition of the steam machinery and propelling apparatus, and the arrangements for passenger and cargo accommodation,—as some recent signs of vitality have been manifested amongst the leading merchants and others in Bristol, where a new line of these improved Transatlantic steamers has been projected, and with every probability of their being successfully established.

In Locomotive Engineering, nothing special has occured, except perhaps, the completion of several of the new Express Engines by Mr. McConnell, for the London and North Western Railway Company, with 18in. cylinders, 24in. stroke, and 7ft. 6in. driving wheels, with 1100 sq. ft. of heating surface, with a total weight of only 33 tons, distributed thus:—13 tons on the driving wheels, 11 tons on the leading wheels, and 9 tons on the trailing wheels. These engines are doing their duty remarkably well. The requirements for working the traffic of the Metropolitan underground railway have necesitated the introduction by Mr. Fowler, of a novel kind of locomotive engine which, is intended to "hold its breath" whilst passing through the tunelled portions of the line, or, to condense the steam after it has done its work, instead of its being emitted from the blast pipe up the chimney, and carrying with it the products of combustion, which would soon fill the tunnels with sulphurous vapours, to the inconvenience and discomfort of the passengers.

The number of railway bills deposited will give plenty of work to the railway engineers and contractors. The metropolitan lines and new stations are all progressing rapidly. The Charing Cross railway bridge, and new station, at Hungerford, are being pushed on with vigour. The metropolitan under-ground railway works are progressing rapidly towards completion, and they are being executed in the most admirable manner by the contractors employed thereon.

The great sewage works for draining the north and south sides of the Thames are being pushed forwards in several parts simultaneously.

The embankment of the Thames on the north side is to be executed with all convenient despatch; and a similar work for the south side is being advocated before a royal commission, with the view of determining the best mode of carrying it into effect.

It only remains to convert the River Thames into a "locked" canal, to increase the value of river side property to the greatest possible extent, and, at the same time, confer many advantages upon the commerce using the River Thames as a highway.

The numerous railway accidents which have occurred during the past year, have been of an unusually serious and fatal character, involving immense losses to the holders of railway stock. And it is to be hoped that the managers of railways will not allow mere prejudice and indolence to stand in the way of the prompt adoption of efficient means for reducing the chances of accidents to a minimum. There are many ingenious and really practical contrivances connected with signalling, which, for one-thousandth part of the cost incurred by the Companies for damages and loss, might effectually secure immunity from some of the classes of accidents, which have recently proved so fatal. The absurd prejudice entertained by some railway people against simple, self-acting, and recording apparatus, is unworthy of this period of the nineteenth century. An uniform system, or codification of signals, would, it is thought, be recognised by railway officials as tending to public security; but the most absurd and contradictory rules are in force in the same district, and practiced by the servants of different companies running their traffic over the same lines of railway. We know that the late Admiral Moorsom, whilst chairman of the London and North Western Railway, when his attention was directed to the subject, just prior to his death, expressed his surprise at the existence of such a condition of things, and stated his intention of giving immediate attention to devising some effective means for its suppression.

The very unsatisfactory financial condition of railway property in British North America and elsewhere, necessitates some immediate and efficient means of enabling the traffic on such railways to be profitably developed; but, as most of them have exhausted their powers of raising capital, the most pressing necessities with which they are afflicted, are the want of locomotives, carriages, and waggon stock; and an excellent practical scheme has been proposed to the attention of those interested in this question, by Mr. T. Vernon Smith, C.E., of St. John's, New Brunswick, and which we consider will efficiently provide for the difficulties to which we have referred, and by which the working of numerous railways may be rendered remunerative to all parties.

The removal of the excise duty on paper has given considerable stimulus to that important branch of manufactures; and, amongst other articles in the manufacture of which paper is being extensively employed, are pipes, for the conveyance of water, gas, and for sewage, and draining purposes.

The numerous accidents which have occurred through boiler explosions during the last twelvemonths, has necessitated the formation of an Association in London, for the Southern division of England, similar to that which has been in operation in Manchester for several years past, and the London Association for the Prevention of Steam Boiler Explosions, and for Effecting Economy in the Raising and Use of Steam, has just been established.

The approaching International Exhibition will, it may fairly be anticipated, prove a success as greatly in advance of the Exhibition of 1851, as the Exhibition of 1851 was as compared with the foreign and other exhibitions which had preceded it. Notwithstanding the recent and much lamented death of His Royal Highness the Prince Consort, Her Majesty has graciously signified her intention of adhering to the programme proposed to be observed at the inauguration, and of opening the Exhibition in person.

We cannot permit this opportunity to pass without expressing how much it is to be hoped that the war which now appears imminent between Great Britain and the Federal Government of North America, may, by all fair and honourable means be averted, as such an event would prove a great calamity, and for a time retard the advancement of civilisation, and the present rapid rate of the progress of arts, manufactures, and commerce on the continent of America, whilst our own manufactures and commerce, would suffer temporary inconvenience. We trust, however, that the despatches from our Minister at Washington, which may be expected to arrive in the course of a few days, will dispel the uncertainty which at present exists as to the solution of the existing difficulty, but whatever the nature of the looked-for communications may be, Her Majesty's Government deserve the highest praise for the unusual alacrity which has been displayed in the present instance, in being forearmed and prepared for any contingency.

There are many other topics to which, if our space permitted, we should have been glad to have addressed ourselves—however briefly, but we are warned we have already exceeded our limits of space; we, therefore, now take leave of our readers, expressing a hope, that they will do their part towards us, by affording us the continuance of that material support by which we are stimulated whilst catering for them.

THE CORK CITIZEN RIVER STEAMER COMPANY'S VESSELS "CITIZEN" AND "LEE."

(*Illustrated by Plate* 205.)

With this number we present our readers with a large Plate Engraving containing three views accurately drawn to scale, of the Cork Citizen River Steamer Company's vessels, *Citizen* and *Lee*, which we have selected as being an illustration of a type of a very useful class of river boats.

We understand that the *Citizen* and *Lee* are the first vessels which have been started by the above Company.

Fig. 1. Elevation; Fig. 2. Plan; Fig. 3. Longitudinal Section. A A, boilers; B, ladies' cabin; C, captain's room; D, dining room; E, refreshment room; F, pantry; G, engineer's berths; H, galley; I, clerk's room.

The following extracts from the specification of, and other particulars relating to these steamers will, no doubt, be interesting to our readers.

DIMENSIONS.

Length over all	165	feet.		
Do. on load water line	158	„		
Breadth of beam	17	„	6	inches.
Do. over paddle boxes	32	„	0	„
Depth moulded	7	„	6	„
Quarter deck raised above main deck	2	„	6	„
Draught of water, with water in boilers and coals in bunkers	3	„	6	„
Nominal power of engines	80 H.P.			

Speed of vessels 16 statue miles per hour. Keel of iron, 5in. × 4in. × $\frac{1}{2}$in., fitted inside of vessel and rivetted to keel plates. Stern and stern post: stern of bar iron 4in. × $1\frac{1}{4}$in. stern post $3\frac{1}{2}$in. × $1\frac{1}{2}$in. Frames: of angle iron $2\frac{1}{2}$in. × $2\frac{1}{2}$in. × $\frac{5}{16}$in. spaced 2ft. apart from centre to centre in engine and boiler space, and to after end of vessel to suit arrangement of cabin windows, 2ft. 6in. apart from bulk-head at fore end of boiler space to stern. Flooring plates: one on every frame $\frac{1}{4}$in. thick in engine and boiler space, and $\frac{3}{16}$in. thick fore and aft. Reverse bars: one on top of every flooring plate of angle iron $2\frac{1}{2}$in. × $2\frac{1}{2}$in. × $\frac{1}{4}$in. in engine and boiler space, and 2in. × 2in. × $\frac{1}{4}$in. for remainder, all extending on each side of vessel 1ft. above point where top of flooring-plate meets frame. Engine-seat: Bow-shaped, formed to suit sole of engines, of plates $\frac{5}{16}$in. thick, and angle iron $2\frac{1}{2}$in. × $2\frac{1}{2}$in. × $\frac{5}{16}$in. Deck beams: Of angle-iron 3in. × $2\frac{1}{2}$in. × $\frac{1}{4}$in., one on every frame, with triangular knees at ends, extending 12in. each way. engine-beams formed of plates $\frac{5}{16}$in. thick, and angle iron $2\frac{1}{2}$in. × $2\frac{1}{2}$in. × $\frac{5}{16}$in. Paddle beams of I iron, 8in. deep × $\frac{1}{2}$in. thick. Covering plates for 75ft. amidships, 12in × $\frac{1}{4}$in., fore and aft, 12in. × $\frac{3}{16}$in., gunwale angle iron, $2\frac{1}{2}$in. × $2\frac{1}{2}$in. × $\frac{1}{4}$in. Bulkheads: A water-tight bulkhead at each end of engine and boiler space, and one at fire-peak, of plates $\frac{3}{16}$in. thick, with stiffening bars of angle-iron $2\frac{1}{2}$in. × $2\frac{1}{2}$in. × $\frac{1}{4}$in., spaced 2ft. 6in. apart. Outside plating: Keel or garboard streak throughout, $\frac{5}{16}$in., second streak throughout, and bottom-up round-turn of bilge for 60ft. amidships, $\frac{1}{4}$in.; remainder of plating, except gunwale, $\frac{3}{16}$in.; gunwale streak, throughout, $\frac{1}{4}$in. Sides of paddle-boxes next centre of vessel formed of plates $\frac{1}{8}$in. thick, stiffened with angle-iron $2\frac{1}{4}$in. × $2\frac{1}{4}$in. × $\frac{3}{16}$in., spaced 2ft. 6in. apart. Brackets for carrying paddle-shafts, formed of $\frac{3}{8}$in. plates and 3in. × 3in. × $\frac{3}{8}$in. angle-iron, strongly made and well secured to vessel's side. Rivetting: Keel stern and stern-post single rivetted, with $\frac{5}{8}$in. rivets, $2\frac{1}{2}$in. apart from centre to centre; garboard streak, the same size and distance; remainder of outside plating, $\frac{1}{2}$in. rivets, 2in. apart from centre to centre, frame rivets $4\frac{1}{2}$in. apart.

CABINS.—The after cabin, dining cabin, and steerage, 7ft. in height from floor to ceiling. After cabin, fitted on both sides with large windows, 18in. × 16in., extending fore and aft, as shown on plan, glazed with plate glass, in strong mahogany frames. Every second window on each side made to lower similar to those of a railway carriage, the remainder fixed. A ladies' cabin, on one side of the staircase, leading to saloon, and captains' cabin on other side. All except steerage fitted with sofas, and backs stuffed with best quality curled hair, and covered with best quality crimson Utrecht velvet.

ENGINES AND BOILERS.—A pair oscillating engines, 80 nominal H.P., collectively; cylinder, 36in. diameter, and 3ft. stroke; feathering paddle wheels, 14ft. 6in. diameter over floats; 10 floats, 6ft. long × 2ft. deep. Boilers:—Two tubular, one before and one abaft engines. Each boiler 2 furnaces, 3ft. 6in. wide × 3ft. 1in. high; 188 brass tubes, 2¾in diameter externally × 6ft. long.

Tenders were invited for one or two vessels according to a specification prepared by Mr. Alex. Crichton, the Company's engineer. The guaranteed speed of vessel, between a measured distance on the river Lee, and with engines of 80 horse-power, with a given draft of water, with 500 passengers on board, was to be specified, and the price and time within which one or two vessels could be completed and delivered.

There were thirteen tenders, including two from the Thames and three from the Mersey; the dimensions and guaranteed speed varying materially. The estimates were from £4900 to £9000. Messrs. Blackwood and Gordon, of Paisley and Port Glasgow, agreed to complete the vessel in four and a half months; the draught of water to be 3ft. 6in.; the speed, 16 statute miles; and we believe the cost of each ship, complete, was about £5250, delivered at Cork and approved.

THE LOSS BY FRICTION OF LOAD IN THE PRINCIPAL PARTS OF THE STEAM ENGINE.

BY OMICRON.

(*Continued from page* 257.)

GEARING SHAFTS.

The loss by friction in the axis of a spur wheel is equal to the product of the co-efficient of friction multiplied by the diameter of the axis and divided by the diameter of the wheel. This supposes that the resultant of the pressure on the teeth is not neutralised by weight of parts, nor by the resultant of other pressures upon the same journals. If d_1 d_2 be the diameters of the wheels, and a_1 a_2 the diameters of their journals

$$f\left(\frac{a_1}{d_1} + \frac{a_2}{d_2}\right)$$

is the loss by the friction of the axes.

I will now give a few numerical examples of these rules.

What is the loss by friction in a direct-acting marine engine, cylinders 85in. diameter, stroke 42in., according to the general formula, $\frac{D}{16\,L} + \frac{1}{60}$?

$$\frac{85}{16 \times 42} + 0{\cdot}0166 = 0{\cdot}143 = \text{loss of indicated power.}$$

$$\frac{0{\cdot}143}{1 - 0{\cdot}143} = 0{\cdot}166 = 16{\cdot}6 \text{ per cent. of the useful work.}$$

What would have been the loss by friction of the engines of the *City of New York* had they been geared engines, 72in. stroke, as in the *City of Baltimore*, but retaining the diameter of cylinder 85in., and taking the other proportions from the *Baltimore*, viz., 119 teeth in wheel, 38 in pinion; the journals of the wheel shaft are ⅛ of the diameter of the wheel and those of the pinon are ¼ of the diameter of the pinion.

$$\frac{D}{16\,L} + 0{\cdot}166 = \frac{85}{16 \times 72} + 0{\cdot}166 = 0{\cdot}0904.$$

$$6\,f\left(\frac{1}{n_1} + \frac{1}{n_2}\right) = \tfrac{1}{12}\left(\tfrac{6}{119} + \tfrac{6}{38}\right) = 0{\cdot}0173$$

$$f\left(\frac{a_1}{d_1} + \frac{a_2}{d_2}\right) = \tfrac{1}{12}\left(\tfrac{1}{8} + \tfrac{1}{4}\right) = 0{\cdot}0312$$

$$1 - 0{\cdot}1389 = 0{\cdot}8611\ \big)\ \underline{0{\cdot}1389}$$

$$0{\cdot}1613$$

The loss would have been 13·89 per cent of the indicated power, or 16·13 per cent of the actual power.

According to this calculation it would appear that the loss of power is the same in both engines. But had the stroke of the engines of the *New York* been reduced in the proportion of the gearing of the *Baltimore* so that the revolutions of the screw shaft would have been the same in each, its length of stroke would have been 24-in., and the loss of power by friction would have been

$$\frac{85}{16 \times 24} + 0{\cdot}0166 = 0{\cdot}221 \text{ of the indicated power.}$$

$$\frac{0{\cdot}221}{1 - 0{\cdot}221} = 0{\cdot}283 \text{ of the actual power.}$$

In 1854 there was an engine made on a patent principle, which involved a crank chaft and crank pin, each of great size in proportion to the size of the engine. The crank shaft was, if I remember correctly, 7½in., the crank pin 2½in., and the length of stroke only 4in. The engine was completed and the vessel made several trips with it but at an enormous sacrifice of power. The formula already given will enable us to determine the loss by friction on these journals; the length of the connecting rod was four times the crank, or $n = 4$.

$$\left(1 + \frac{1}{4\,n}\right)\frac{f\,\pi}{L}\,(r_1 + r_2) = \left(1 + \tfrac{1}{16}\right) \times \frac{3{\cdot}1416}{12 \times 4} \times \left(3\tfrac{3}{4} + 1\tfrac{1}{4}\right) = 0{\cdot}347.$$

$$\frac{0{\cdot}347}{1 - 0{\cdot}347} = 53{\cdot}1 \text{ per cent. of the useful work.}$$

Had this calculation been made before the engine was constructed, the impropriety of the principle would have been admitted. But there were other sources of friction than those which have been examined; there were three stuffing glands also upon the shaft which, when tightened to be steam tight, added perhaps as much to the friction as the shaft and pin did. I refer to this engine here because the record of a failure is as important as is an account of a success. Schemers of new engines would do well to examine their inventions by the laws of friction, for many very ingenious combinations of parts which would act well enough according to the laws of mechanics, become impracticable by reason of the friction tax.

In oscillating engines the radius of the trunnion is to be substituted for that of the crosshead, and instead of the length of the connecting rod, use the distance between the centre of trunnion aud the centre of the crank shaft. There is no additional pressure arising from obliquity, because the pressure on the crank pin is always equal to the pressure on the piston. There is more friction on the gland of the cylinder cover, and of the piston on the sides of the cylinder, than in other engines, but the additional pressure is only that necessary to overcome the friction on the trunnions, and, under ordinary circumstances, may be neglected in the calculation of friction.

In paddle engines the friction on the paddle shaft journals is that arising from weight of parts which has already been referred to, added to that arising from the transmission of work. The loss by work in parts of the work, is represented by the product of the co-efficient of friction multiplied by the diameter of the journal, and divided by the effective diameter of the wheel. This is similar to the rule for loss by friction on the journals of gearing shafts.

In addition to the friction of transmitted power which has been treated of in this paper, there is the friction due to the weight of the parts of the engine itself and the power expended on the working of the pumps and slide valves. These are variously estimated by different writers. When the co-efficient of friction is $\frac{1}{12}$, the loss of the power by the friction of the piston in the cylinder is, according to Tredgold, 3 per cent, of the power of the engine. Tredgold also calculates the power required to work the air pump to be 5 per cent. of the whole power, If we add 2 per cent. for the other expenditures of power on the unloaded engine we have a total of 10 per cent. of the indicated power in addition to the friction of the load already calculated. This is somewhat in excess of the actual loss in large engines, and instead of a percentage of the whole power, this loss is generally taken at so much per square inch of piston.

In the condensing engine this loss is not over estimated at 1½lbs. per square inch, and it is usual to make this allowance. The general formula for total loss of useful effect, including friction of load, as well as friction of the engine itself, wili be

$$\frac{D}{16\,L} + \frac{1}{60} + \frac{3}{2\,p},$$

when p is the average effective pressure on the piston. If $p = 30$ this deduction for the friction of the engine itself is 5 per cent. of the whole power, and this, added to the friction of the load in the engines of the *City of New York*, gives a total loss when $p = 30$, equal to 19·3 per cent. of the indicated power.

PUBLIC LIGHTING IN THE PROVINCES.

By SAMUEL HUGHES, C.E., F.G.S.

Table showing the prices paid for gas in the public lamps for all the principal towns in the United Kingdom.

This table is a continuation of that published by the Managers of the Metropolis Gas Inquiry in September, 1859, but extends to a much greater number of towns, since the table of 1859 comprised only about 70 towns, while the present table contains complete returns from more than 150 of the principal places in Great Britain and Ireland.

The headings of the various columns sufficiently explain the information conveyed by the table. The principal columns, which contain the result of the whole matter, are those numbered 10 and 11. The 10th column gives the price paid for gas alone in the public lamps, and column 11 shows the comparative price paid by the private consumer. The notes at the end of the table contain a mass of additional and explanatory information which could not conveniently be tabulated.

The following statements are reprinted from the first edition of these tables, published in 1859:—

"In all the 70 towns comprised in this table, the average price paid for gas alone supplied to public lamps amounts to 75 per cent. of the price paid by the private consumer.

"I have recently examined returns from no less than 91 cities and towns in America. In 54 of these the local authorities light and extinguish their own lamps. In 33 out of the whole number the gas consumed by public lamps is paid for at a price per 1000 feet; and an accurate analysis has shown that in several cases the price paid for the gas in the public lamps is only half of that paid by the private consumer.

"The average of the whole 33 towns gives the price of gas in the public lamps equal to 75 per cent. of that paid by the private consumer, showing a remarkable coincidence with the result obtained from a similar extensive examination in Great Britain."

Considerable alterations have taken place in the prices and the lighting arrangements of various towns since the publication of the first tables on this subject; in addition to which more than double as many places are included in this table; yet the same proportion still holds between the prices charged for public and private lighting, namely, the average price paid for gas alone supplied to the public lamps throughout the United Kingdom is exactly 75 per cent. of that paid by the private consumer.

PUBLIC LIGHTING IN THE PROVINCES.

* T means the Town Council Corporation or other local authority. † Co. means the Gas Company.

NAME OF CITY OR TOWN.	Price paid for each public lamp per annum.	To whom the lamps belong.	Who lights, extinguishes, paints, and repairs.	Number of hours per annum during which each lamp burns.	Cubic ft. per hour consumed by each lamp, as per contract.	Deduction for use of lamps, lighting, extinguishing, repairing, &c.	Price paid for gas alone per lamp per annum.	Cubic feet of gas consumed by each lamp per annum.	Price paid per 1000 feet for gas alone in public lamps.	Price per 1000 feet paid by private consumers.
1	2	3	4	5	6	7	8	9	10	11
	s. d.					s. d.	s. d.		s. d.	s. d.
Aberdeen	11 8	T.	T.	2660	$\frac{3}{4}$	None.	11 8	1,995	5 10	5 10
Airdrie	7 6	"	"	1000	$2\frac{1}{7}$	None.	7 6	2,143	3 6	5 0
Arbroath	6 $4\frac{1}{3}$	"	"	1219	1	None.	6 $4\frac{1}{2}$	1,219	5 $2\frac{3}{4}$	5 10
Ashby-de-la-Zouch	60 0	Co.	Co.	3942	5	16 0	44 0	19,710	2 $2\frac{3}{4}$	6 0
Ayr	13 0	T.	T.	2118	1	None.	13 0	3,184	4 1	5 10
Banbury	56 6	Co.	Co.	2310	5	13 0	43 6	11,550	3 9	5 0
Bangor	26 8	T.	T.	700	4	None.	26 8	2,800	9 6	6 0
Barnsley	35 0	Co.	Co.	2000	4	11 0	24 0	8,000	3 0	4 0
Bath	60 0	"	"	3650	4	16 0	44 0	14,600	3 0	4 6
Belfast	45 0	"	"	3620	4	10 0	35 0	14,480	2 5	4 2
Bilston	46 0	T.	"	2400	5	7 0	39 0	12,000	3 3	5 6
Birmingham	70 0	"	"	3942	5	13 0	57 0	19,710	2 11	3 9
Blackburn	33 4	"	T.	2486	4	None.	33 4	9,944	3 4	4 0
Bolton	25 1	"	"	2046	$3\frac{1}{2}$	None.	25 1	7,161	3 6	3 6
"	17 11	"	"	2046	$2\frac{1}{2}$	None.	17 11	5,115	3 6	3 6
"	11 11	"	"	2046	$1\frac{2}{3}$	None.	11 11	3,410	3 6	3 6
Bradford	48 0	"	Co.	3856	4	10 0	38 0	15,424	2 $5\frac{1}{2}$	3 4
Brighton	80 0	"	"	4308	5	13 0	67 0	21,540	3 1	5 0
Bristol	100 0	"	"	3613	7	13 0	87 0	25,291	3 5	3 9
"	75 0	"	"	3613	5	13 0	62 0	18,065	3 5	3 9
"	60 0	"	"	3613	$2\frac{1}{2}$	13 0	47 0	9,032	5 2	3 9
"	36 0	"	"	3613	1	13 0	23 0	3,613	6 4	3 9
Buckingham	32 0	"	"	1630	4	8 0	24 0	6,520	3 8	6 3
Burnley	44 0	Co.	"	2000	5	11 0	33 0	10,000	3 $3\frac{1}{2}$	3 6
Burslem	58 0	T.	"	...	...	...	...	...	...	4 6
Bury	26 4	Co.	"	2200	$3\frac{1}{2}$	11 0	15 4	7,700	2 0	4 6
Cambridge	80 0	"	"	4308	$4\frac{1}{2}$	16 0	64 0	19,386	3 $3\frac{1}{2}$	5 0
Cardiff	66 0	T.	"	3600	$4\frac{1}{2}$	16 0	50 0	16,200	3 1	4 3
Carlisle	53 0	Co.	"	3600	5	16 0	37 0	18,000	2 $0\frac{3}{4}$	4 0
"	42 0	"	"	3600	$3\frac{1}{2}$	16 0	26 0	12,600	2 $0\frac{3}{4}$	4 0
"	31 0	"	"	3600	2	16 0	15 0	7,200	2 1	4 0
Chelmsford	70 0	T.	"	2849	5	10 0	60 0	14,245	4 $2\frac{1}{2}$	5 5
"	20 6	"	"	636	5	5 0	15 6	3,180	4 $10\frac{1}{2}$	5 5
Cheltenham	76 4	Co.	"	3684	$4\frac{1}{2}$	16 0	60 4	16,578	3 8	5 0
Chester	60 0	"	"	3650	3	16 0	44 0	10,950	4 $0\frac{1}{4}$	4 6
"	69 4	"	"	3650	4	16 0	53 4	14,600	3 $7\frac{3}{4}$	4 6
"	50 0	"	"	3080	3	16 0	34 0	9,240	3 $8\frac{1}{4}$	4 6
"	63 0	"	"	3080	4	16 0	47 0	12,320	3 $9\frac{3}{4}$	4 6
Chesterfield	50 0	"	"	2200	5	12 0	38 0	11,000	3 $5\frac{1}{2}$	5 0
Chichester	100 0	"	"	4200	5	16 0	84 0	21,000	4 0	6 8
Colchester	58 0	T.	"	2700	$4\frac{1}{2}$	11 0	47 0	12,150	3 $10\frac{1}{2}$	5 0
Congleton	42 0	"	"	2527	4	7 0	35 0	10,108	3 $5\frac{1}{2}$	4 6
Cork	70 0	Co.	"	4308	4	16 0	54 0	17,232	3 $1\frac{1}{2}$	4 6
Coventry	50 0	"	"	3100	5	16 0	34 0	15,500	2 $2\frac{1}{4}$	4 6
Croydon	94 1	"	"	3619	5	16 0	78 1	18,095	4 $3\frac{3}{4}$	5 6
,	77 0	"	"	2667	5	13 0	64 0	13,335	4 $9\frac{1}{2}$	5 6

PUBLIC LIGHTING IN THE PROVINCES—*continued.*

NAME OF CITY OR TOWN.	Price paid for each public lamp per annum.	To whom the lamps belong.	Who lights, extinguishes, paints, and repairs.	Number of hours per annum during which each lamp burns.	Cubic ft. per hour consumed by each lamp, as per contract.	Deduction for use of lamps, lighting, extinguishing, repairing, &c.	Price paid for gas alone per lamp per annum.	Cubic feet of gas consumed by each lamp per annum.	Price paid per 1000 feet for gas alone in public lamps.	Price per 1000 feet paid by private consumers.
1	2	3	4	5	6	7	8	9	10	11
	s. d.					s. d.	s. d.		s. d.	s. d.
Darlington	50 0	Co.	Co.	2744	5	13 0	37 0	13,720	2 8¼	4 2
Daventry	47 8	...	"	...	...	...	...	...	...	8 4
Denbigh	42 0	T.	"	1253	4	7 0	35 0	5,012	7 0	10 0
Derby	43 3	"	T.	3205	5	None.	43 3	16,025	2 8½	3 7
"	28 4½	"	"	2100	5	None.	28 4½	10,500	2 8½	3 7
Dewsbury	31 6	"	"	2618½	3	None.	31 6	7,855	4 0	4 0
Doncaster	60 0	Co.	Co.	3704	4½	12 0	48 0	16,668	2 10½	3 9
Dover	63 0	"	"	4164	4½	16 0	47 0	18,738	2 6	5 10
"	35 0	"	"	4164	2½	16 0	19 0	10,410	1 10	5 10
Dublin	64 6	"	"	3510	4	16 0	48 6	14,040	3 5½	4 9
Dumfries	6 9	T.	T.	...	3	None.	6 9	...	6 9	7 6
Dundee	9 3	"	"	2217	1	None.	9 3	2,217	4 2	5 6
Dunfermline	13 6	"	"	1745	2	None.	13 6	3,490	3 10½	4 7
"	5 10	"	"	755	2	None.	5 10	1,510	3 10½	4 7
Durham	36 0	Co.	Co.	3233	4	16 0	20 0	12,932	1 6½	4 0
Eastbourne	85 0	T.	"	2768	5	7 0	78 0	13,840	5 8	6 8
Edinburgh	25 0	"	T.	3926	2	None.	25 0	7,852	3 2¼	5 5
"	15 0	"	"	3926	1	None.	15 0	3,926	3 9¾	5 5
Edmonton	80 0	"	Co.	3308	5	7 6	72 6	16,540	4 4½	6 0
Elland	32 0	"	"	2537	4	6 0	24 0	10,148	2 4½	4 0
Ely	70 0	Co.	"	2500	5	13 0	57 0	12,500	4 6¾	6 8
Epsom	75 10	T.	"	2450	5	8 10	67 0	12,250	5 5¾	6 8
Exeter	67 6	...	...	...	...	...	...	...	...	5 6
Folkestone	70 2	T.	"	3179	4½	9 2	61 0	14,305	4 3¼	5 6
Forfar	6 9	"	T.	...	1	None.	6 9	...	6 9	7 6
Gainsborough	50 0	Co.	Co.	1800	5	11 0	39 0	9,000	4 4	5 0
Gateshead	44 0	T.	"	3473	5	12 0	32 0	17,365	1 10¼	4 0
Glasgow	29 2	"	T.	3446	2	None.	29 2	6,892	4 2¾	5 0
Gloucester	95 0	Co.	Co.	...	...	...	...	...	...	5 0
Grenock	52 6	T.	T.	3842	3	None.	52 6	11,526	4 6¾	5 0
"	35 0	"	"	3842	2	None.	35 0	7,684	4 6¾	5 0
Guildford	90 0	Co.	Co.	4308	5	16 0	74 0	21,540	3 5¼	6 6
Halifax	36 0	T.	T.	4111	5	None.	36 0	20,555	1 9	4 0
Harrowgate	40 0	Co.	Co.	1200	4	10 0	30 0	4,800	6 3	5 10
Hartlepool		"	"	...	5	...	...	...	...	4 2
Harwich	70 0	T.	"	2400	5	9 0	61 0	12,000	5 1	6 9
Hertford	67 0	Co.	"	2524	5	11 0	56 0	12,620	4 5¼	6 0
Hereford	80 0	...	"	...	...	...	...	...	...	5 0
Horsham	63 0	T.	"	3279	4½	10 0	53 0	14,755	3 7	5 10
Huddersfield	34 0	"	T.	3750	3½	None.	34 0	13,125	2 7	4 0
Hull	90 0	Co.	Co.	4000	5	16 0	74 0	20,000	3 8½	4 6
"	80 0	T.	"	4000	5	13 0	67 0	20,000	3 4½	4 6
"	75 0	Co.	"	4000	5	16 0	59 0	20,000	2 11½	4 6
Inverness	49 2	T.	T.	3279	2	None.	49 2	6,558	7 6	7 6
Ipswich	77 6	Co.	Co.	4308	5	16 0	61 6	21,540	2 10¼	4 6
Irvine	21 0	T.	"	2664	2	9 0	12 0	5,328	2 3	5 10
Kilmarnock	12 0	"	T.	2400	1	None.	12 0	2,400	5 0	5 10
Lancaster	26 0	Co.	"	2400	2¾	3 0	23 0	6,600	3 5¾	5 0
Leeds	35 6	T.	"	3787	3	None.	35 6	11,361	3 1½	3 9
Leicester	55 2	"	"	3303	4½	None.	55 2	14,863	3 8½	3 11
Leith	15 0	"	"	3926	1	None.	15 0	3,926	3 9¾	5 5
Lichfield	37 6	Co.	Co.	1020	5	11 6	26 0	5,100	5 1¼	5 0
Lincoln	38 5	T.	T.	2400	4	None.	38 5	9,600	4 0	4 2
Liverpool	77 7	"	Co.	3618	4	12 7	59 0	14,472	4 1	3 9
Londonderry	60 0	Co.	"	3494	4	16 0	44 0	13,976	3 1¾	5 0
Luton	56 6	"	"	3650	4	16 0	40 0	14,600	2 9	5 8
Lynn	55 0	"	"	2983	5	12 0	43 0	14,915	2 10½	5 0
Macclesfield	39 0	T.	"	2400	4	7 6	31 6	9,600	3 3¼	4 6
Maidenhead	50 0	Co.	"	2274	5	11 0	39 0	11,370	3 5¼	7 6
Manchester	33 7	T.	T.	3655	2¾	None.	33 7	10,051	3 4	4 0
Montrose	15 11	"	"	1493	2⅕	None.	15 11	3,285	4 10¼	5 0
"	7 5	"	"	1493	1	None.	7 5	1,493	4 11½	5 0
Newcastle-under-Lyne	52 6	"	Co.	2962	5	9 0	43 6	14,810	2 11¼	5 0
Newark	44 0	Co.	"	1700	5	11 0	33 0	8,500	3 10½	4 2
Northampton	65 11	"	"	2681	5	12 4	53 7	13,405	4 0	5 0
North Shields	45 0	T.	"	3566	5	10 0	35 0	17,830	1 11½	4 0
Northwich	50 0	Co.	"	3279	3	12 0	38 0	9,837	3 10¼	6 8
Norwich	78 6	"	"	3574	5	16 0	62 6	17,870	3 6	4 6
Nottingham	55 4	T.	"	3650	5	13 0	42 4	18,250	2 3¼	3 5¼
Newcastle-upon-Tyne	30 0	Co.	Co.	3289	5	None.	30 0	16,445	1 10	4 0

PUBLIC LIGHTING IN THE PROVINCES—*continued.*

NAME OF CITY OR TOWN.	Price paid for each public lamp per annum.	To whom the lamps belong.	Who lights, extinguishes, paints, and repairs.	Number of hours per annum during which each lamp burns.	Cubic ft. per hour consumed by each lamp, as per contract.	Deduction for use of lamps, lighting, extinguishing, repairing, &c.	Price paid for gas alone per lamp per annum.	Cubic feet of gas consumed by each lamp per annum.	Price paid per 1000 feet for gas alone in public lamps.	Price per 1000 feet paid by private consumers.
1	2	3	4	5	6	7	8	9	10	11
	s. d.					s. d.	s. d.		s. d.	s. d.
Oldham	35 0	T.	T.	3053	3½	None.	35 0	10,685	3 3¼	4 0
Otley	26 0	„	„	...	...	...	...	5,214	5 0	5 10
Oxford	57 6	„	Co.	2468	4½	10 0	47 6	11,106	4 3¼	5 0
Paisley	13 2	„	T.	2875	1	None.	13 2	2,875	4 7	4 7
Perth	19 0	„	„	1727	2	None.	19 0	3,454	5 6	7 6
Plymouth	75 0	Co.	Co.	3943	4	16 0	59 0	15,772	3 9	3 4
Portsea	80 0	T.	„	3578	5	10 0	70 0	17,890	3 11	4 6
Portsmouth	80 0	„	„	4308	5	10 0	70 0	21,540	3 3	4 6
Preston	41 6	„	T.	3071	4	None.	41 6	12,284	3 4½	4 9½
Reading	65 0	„	Co.	3229	4	10 0	55 0	12,916	4 3	6 0
Redditch	60 0	„	„	2600	5	9 0	51 0	13,000	3 11	5 6
Rochdale	26 9	„	T.	2000	3¾	None.	26 9	7,500	3 6¾	4 0
Rotherham	47 0	Co.	Co.	2000	5	11 0	36 0	10,000	3 7	4 7
St. Ives, Hunts	50 7	T.	T.	2500	4½	None.	50 7	11,250	4 6	6 8
St. Neots	30 0	Co.	Co.	792	4	7 0	23 0	3,168	7 3	6 8
Salford	30 0	T.	T.	3000	2½	None.	30 0	7,500	4 0	4 4
Salisbury	35 0	„	Co.	1105	5	9 0	24 0	5,525	4 4¼	6 0
Scarboro'	64 9	Co.	„	3600	4½	None.	64 9	16,200	4 0	5 10
„	25 2	„	„	1400	4½	None.	25 2	6,300	4 0	5 10
Sheffield	56 9	T.	T.	3123½	5	None.	56 9	15,617	3 7½	3 9
Shrewsbury	72 6	Co.	Co.	3285	5	16 0	56 6	16,425	3 5¼	5 0
„	39 6	„	„	3285	2	16 0	23 6	6,570	3 7	5 0
Southam	...	T.	T.	...	...	...	...	...	...	7 6
Southampton	87 0	„	Co.	3757	4	13 0	74 0	15,028	4 11	5 6
South Shields	49 6	„	„	2911	5	8 0	41 6	14,555	2 10¼	4 0
Spalding	62 6	Co.	„	2200	4½	10 6	50 0	9,900	5 0½	5 6
Stamford	53 0	„	„	1800	4½	12 0	41 0	8,100	5 0¾	5 6
Stirling	30 0	T.	T.	...	...	...	...	...	...	6 0
Stroud	56 0	Co.	Co.	2130	4	13 0	43 0	8,520	5 0½	5 0
Sunderland	56 3	T.	„	3184½	5	7 6	48 9	15,922½	3 0¾	4 0
Swansea	67 6	„	„	4308	5	13 0	54 6	21,540	2 6½	4 0
Tamworth	48 0	Co.	„	2225	4	12 0	36 0	8,900	4 0½	6 6
Tavistock	65 0	T.	„	3751	4	12 0	53 0	15,004	3 6½	5 10
Thirsk	31 6	Co.	„	1100	4½	...	...	...	...	6 8
Torquay	65 5	T.	T.	2380	5	None.	65 5	11,900	5 6	5 6
Totnes	54 11	„	Co.	4308	5	13 0	41 11	21,540	1 11¼	6 3
Tottenham	80 0	„	„	3195	5	10 0	70 0	15,975	4 4½	6 0
Tynemouth	45 0	„	„	3566	5	10 0	35 0	17,830	1 11½	4 0
Uxbridge	55 0	„	„	3890	4	13 0	42 0	15,560	2 8½	5 6
„	60 0	„	„	2961	4	10 0	50 0	11,844	4 2¾	7 0
Wakefield	42 8	Co.	„	2349	4	7 6	35 2	9,396	3 9	3 9
Wallingford	42 0	„	„	1400	4	8 0	34 0	5,600	6 0¾	10 0
Warrington	54 0	„	„	3118	3	13 0	41 0	9,354	4 4½	4 6
Warwick	62 6	„	„	2236	5	11 0	51 6	11,180	4 7¼	6 0
Watford	70 0	T.	„	3447	5	12 0	58 0	17,235	3 4½	6 0
Walsall	60 0	Co.	„	2100	7	13 0	47 0	14,700	3 2¼	3 4
Wellington	42 0	T.	„	2016	4½	7 0	35 0	9,072	3 10¼	5 0
Wells	70 0	Co.	„	3611	5	14 0	56 0	18,055	3 1¼	6 0
West Ham	105 0	T.	„	3578	5	13 0	92 0	17,890	5 1¾	5 0
Weymouth	45 0	Co.	„	3580	5	14 0	31 0	17,900	1 8¾	5 6
Whitehaven	48 0	T.	„	4308	5	13 0	35 0	21,540	1 7½	2 6
„	35 6	„	„	3572	5	9 6	26 0	17,860	1 5½	2 6
„	25 0	„	„	3572	2½	9 6	15 6	8,930	1 8¾	2 6
Wigan	31 6	Co.	„	2000	...	13 0	18 6	...	...	5 0
Winchester	80 0	T.	„	3289	4	11 0	69 0	13,156	5 3	6 0
Wisbech	56 0	Co.	„	...	5	...	...	...	...	5 0
Wolverhampton	74 0	„	„	3391	5	14 0	58 0	16,955	3 5	4 9
Worcester	70 0	„	„	3285	5	14 0	54 0	16,425	3 3½	5 6
Worthing	44 5	„	T.	2791	2¾	6 0	38 5	7,675	5 0	6 8
Wrexham	78 0	T.	Co.	3611	4	14 0	69 6	14,444	4 9¾	5 10

NOTES TO THE TABLE OF PUBLIC LIGHTING IN THE PROVINCES.

Aberdeen.—The price paid for gas in the public lamps is 5¼*d.* per 100 hours. The price to the private consumer has lately been reduced from 6*s.* 6*d.* to 5*s.* 10*d.* per 1000ft. No discounts are allowed where the consumption is under 25,000ft. per annum. Above this amount discounts are allowed, varying from 2*d.* to 1*s.* 4*d.* per 1000 feet. The price paid for the public lamps is subject to the same discounts. The gas at Aberdeen is about 26 candle power, so that the highest price paid is 2·7 pence per candle, which is equivalent to 2*s.* 8*d.* per 1000ft. for 12 candle gas. The burners used in the public lamps at Aberdeen are Cockspur jets, and the consumption is determined by periodical experiments.

Airdrie.—Consumption ascertained by experiment. The price to the private consumer has lately been reduced from 5*s.* 10*d.* to 5*s.* per 1000ft., and for public lighting from 5*s.* 3*d.* to 3*s.* 6*d.* per 1000ft.

Arbroath.—Consumption ascertained by experiment.

Ashby de la Zouch.—Lamps lighted from half an hour after sunset to half an hour before sunrise. No quantity specified in contract, so that 5ft. is an assumption. The price to the private consumer subject to discounts from 0 to 33 per cent.

Ayr.—The price has been reduced since last return from 6*s.* 8*d.* to 5*s.* 10*d.* per 1000ft. to private consumers, and from 5*s.* to 4*s.* 1*d.* per 1000ft. for public lamps.

Bangor.—The case of Bangor is peculiar and exceptional. Mr. Hardie, the Engineer of the Local Board, assures me that the particulars in the table are correct; that the lamps only burn from 650 to 700 hours a year, and consume from 3 to 4 feet an hour. Taking the lowest of these, the price paid for gas in the public lamps would be nearly 14*s.* per 1000ft., while the private consumer only pays 6*s.* Formerly the price was ⅝ of a penny per hour, which amounted to £1 2*s.* per annum, including the lighting and repairing.

Barnsley.—Price of gas reduced from 4*s.* 6*d.* to 4*s.* since last return.

Belfast.—The lamp posts belong to the town, and are painted by the town. The lamps and brackets belong to the company. The price to the private consumer is subject to discounts varying from 2½ to 20 per cent.

Bilston.—The price for the public lamps has lately been reduced from £2 15*s.* to £2 6*s.* per lamp. The town paints and repairs the lamps and posts. The price to private consumer descends from 5*s.* 6*d.* to 4*s.* 6*d.*, according to consumption.

Birmingham.—This town is lighted by two companies, who light, extinguish, and repair, but do not paint the lamp posts. The lamps belong to the companies, the posts to the town. The lamps are lighted all the year round from half an hour after sunset to half an hour before sunrise. The price to private consumer has been reduced from 4*s.* to 3*s.* 9*d.* per 1000ft., with discounts varying from 0 to 25 per cent. When tried by me in Feb. 1860, the gas had an illuminating power equal to 15 candles, as indicated by the bromine test, before the carbonic acid was absorbed. The gas, however, usually contains a large amount of carbonic acid. Meters are supplied rent free to the consumers by both the companies in Birmingham.

Blackburn.—The lighting, extinguishing, repairing, &c., cost the town 9*s.* 4*d.* per lamp per annum. The price to large private consumers is 3*s.* 9*d.* per 1000ft. Gas, when tried by me in March, 1861, equal to 17⅓ candles.

Bolton.—The prices for the three kinds of public lamps have been lately reduced from £1 9*s.* 10*d.* to £1 5*s.* 1*d.*, from £1 1*s.* 8*d.* to 17*s.* 11*d.*, and from 16*s.* 1*d.* to 11*s.* 11*d.* The price to private consumers has also been reduced from 5*s.*, with discounts, to an uniform rate of 3*s.* 6*d.* The illuminating power, when examined by me during numerous experiments between December, 1860, and March, 1861, did not exceed 16 sperm candles; but, in consequence of proceedings by the corporation in the last session of Parliament, is probably not less than 20 candles at the present time. The company has lately consented to the Local authorities lighting their own lamps, and efforts are being made to have the consumption ascertained by meter in the proper manner. The present cost to the corporation of lighting, cleaning, extinguishing, and repairing, is about 8*s.* 8*d.* per lamp per annum.

Bradford.—The company light and extinguish. The corporation paint and repair. The price to private consumers has lately been reduced from 4*s.* to 3*s.* 4*d.*, with discounts varying from 5 to 25 per cent. The gas, when tried by me at both the manufacturing stations of the company, had an average illuminative power equal to 14¼ sperm candles.

Bristol.—The price appears much too high for all the lamps, but especially so for those burning 2½ft. and 1ft. an hour respectively. The gas is properly and regularly tested in Bristol by an officer of the Local Board of Health, so that it is probable the Parliamentary standard of twelve sperm candles is now maintained. The gas was considerably below the standard before this officer was appointed. The price to all consumers, except the rate-payers who pay for the public lamps, has lately been reduced from 4*s.* to 3*s.* 9*d.* per 1000ft.

Buckingham.—The company light and extinguish only; the town paints and repairs.

Burnley.—The works here belong to the corporation, who have lately reduced the price of gas from 4*s.* 6*d.* to 3*s.* 6*d.* per 1000ft.

Bury.—The works belong to the Improvement Commissioners, who do the lighting, extinguishing, and repairing, thus occupying the position of a company. The gas is invoiced to consumers at 5*s.* per 1000ft., from which 10 per cent. is deducted for prompt payment, and also another 10 per cent. for profit on the works, making the real price about 4*s.* per 1000ft. The gas, when tried by me in March last, had an illuminating power equal to 16½ sperm candles.

Cambridge.—The price lately reduced from 5*s.* 6*d.* to 5*s.* per 1000ft.

Cardiff.—The price reduced to 3*s.* 6*d.*, according to consumption.

Carlisle.—The works here belong to the corporation, who profess to supply gas equal to 15 sperm candles. They use 7½ per cent. of Cannel coal. The price has lately been reduced from 4*s.* 2*d.* to 4*s.*, with discounts which bring down the price to 3*s.* 4*d.* in the case of the largest consumers. The gas, when I tried it in February, 1860, had an illuminating power of twelve candles.

Chelmsford.—The price charged is £3 10*s.* for lamps burning during the winter months, and £1 0*s.* 6*d.* for those in the summer months. The winter lamps burn on the average ten hours a night, and the summer lamps six hours. The gas company light, extinguish, and clean the lamps, but the Local Board paints and repairs.

Cheltenham.—The price paid by contract for gas in the public lamps is 3*s.* 10*d.* per 1000ft., with 5 per cent. discount.

Chesterfield.—The contract quantity is 5ft. an hour, but the manager of the gas company who makes the return says the lamps burn 6½ft. an hour. The price to private consumer is 5*s.*, with a discount of 5 per cent. on all accounts exceeding £10 a-year.

Colchester.—The price to private consumer has been reduced since last return from 6*s.* to 5*s.* per 1000ft. The price for public lamps has been reduced by a contract just entered into from £3 5*s.* for 4$\frac{1}{10}$ft. an hour, to £2 18*s.* for 4½ft., making a reduction in the net price of gas from 4*s.* 11¾*d.* to 3*s.* 10½*d.* per 1000ft.

Congleton.—The company light and extinguish, the town paints and repairs the lamps and posts. The lamps are lighted from 11th August to 15th May, from one hour after sunset to one hour before sunrise, with certain exceptions at full moons.

Coventry.—The price, consumption, and time of burning for public lamps are fixed by the Coventry Gas Act.

Croydon.—The lamps at £4 14*s.* 1*d.* are lighted all the year round; those at £3 17*s.* are lighted only during nine months. From 25th March to 29th September, the lamps are all lighted within 1¾ hours after sunset, and are all extinguished earlier than 1¾ hours before sunrise. From 29th September to 25th March, the lamps are lighted within ¾ hour after sunset, and none extinguished till 1¼ hour before sunrise.

Darlington.—The gas works here belong to the Local Board of Health, who light the lamps from sunset to sunrise from the middle of August to the middle of May, with certain exceptions, on moonlight nights. The price to the private consumer has lately been reduced from 4*s.* 6*d.* to 4*s.* 2*d.* per 1000ft., with discounts making the price to large consumers 3*s.* 6*d.* per 1000ft.

Denbigh.—The lamps are lighted, from the beginning of October to the end of March, from twilight to 1 A.M., except on moonlight nights, which I have assumed to be five nights in each moon. No quantity specified in contract; but the town clerk agrees with the manager of the gas Company that the quantity is about 4ft. an hour. The price to private consumers is graduated according to consumption from 10*s.* down to 6*s.* 8*d.* per 1000ft.

Derby.—The lamps are paid for by contract, at the rate of 13*s.* 6*d.* per 1000 hours, or about 2*s.* 8½*d.* per 1000ft.

Doncaster.—All the public lamps burn from the beginning of September till the middle of May. About 80 out of the whole number of 245 burn all the year round. The average time of burning computed for all the lamps is 3704 hours per annum. The works belong to the corporation. There is no contract as to quantity, but the estimated consumption is from 4ft. to 5ft. The price to private consumers is subject to discounts varying from 5 to 20 per cent., and the Great Northern Railway Company is only charged 2*s.* 6*d.* per 1000ft.

Dover.—The price to private consumers is subject to discounts varying from 10 to 20 per cent., if accounts be paid within six months.

Dumfries.—The price paid for the public lamps is 6*s.* 9*d.* per 1000ft. The price to private consumers subject to discounts varying from 0 to 10 per cent.

Dundee.—The price by contract for public lamps is 4*s.* 2*d.* per 1000 hours of burning. The price to private consumers subject to discounts varying from 2½ to 20 per cent.

Dumfermline.—The consumption of the public lamps is determined by twelve meters placed in different parts of the town. The lamps are never lighted during moonlight nights, and only during eight months of the year. The price for gas consumed in public lamps has been reduced since last return from 4*s.* 5*d.* to 3*s.* 10½*d.* per 1000ft. The price to private consumers is subject to discounts ranging up to 15 per cent., and has lately been reduced from 5*s.* to 4*s.* 7*d.* per 1000ft.

Durham.—All the lamps are lighted at sunset, and one-half are extinguished at midnight. They burn on the average 3233 hours per annum. No quantity is specified in the contract, so that a consumption of 4ft. an hour has been assumed.

Eastbourne.—The company light, extinguish, and clean the lamps. The town paints and repairs.

Edinburgh.—Price to private consumers lately reduced from 5*s.* 10*d.* to 5*s.* 5*d.*, with discounts varying from 5 to 10 per cent.

Edmonton.—The company light, extinguish, and clean. The Board of Health paint and repair. Section 52 of the Tottenham and Edmonton Gas Act, 186, provides that the charge for lighting, extinguishing, and cleaning the public lamps, and supplying gas during each night from half an hour after sunset till half an hour before sunrise, between the 15th day of August and the 15th day of May following, in each year, shall not exceed £4 per annum.

Elland.—The company light and extinguish; the town paints and repairs. The lamps are lighted from dusk to 6 A.M., between the 1st of September and the 1st of May, except on five nights at each full moon.

Epsom.—The lamps are lighted on the average 11⅔ hours per night, from the 1st September to the 30th April, excepting four nights at each full moon.

Folkestone.—The company light and extinguish; the town paints and repairs. The lamps are lighted all the year round, from half an hour after sunset to half-an hour before sunrise, except on six nights at each full moon. The consumption has been tested by meter.

Forfar.—The price paid for public lamps is 6*s.* 9*d.* per 1000 hours. The price to private consumers is subject to discounts varying from 2½ to 20 per cent.

Gainsborough.—No information as to quantity consumed per hour. This has been assumed at 5ft.

Gateshead.—The price paid is 1*s.* per lamp per week throughout the year. Three-fourths of the lamps are lighted from sunset to sunrise all through the year. The remaining fourth are only lighted from 21st April to 21st August in each year. The price to private consumers is subject to discount of 10 per cent. if paid within a month.

Greenock.—The price to private consumers subject to discounts varying from 2½ to 20 per cent.

Halifax.—The works belong to the Corporation. The consumption has been tried by meters attached to several lamps, and found to be 5ft. an hour. This gas, when tried by me in February last, had an illuminating power equal to 13½ sperm candles.

Harrogate.—This appears to be an exceptional case, in which, according to the return from the town clerk, the gas supplied to the public lamps is charged at a higher price than to the private consumer.

Hartlepool.—The Local Board pay the gas company 2*s.* 9*d.* per lamp per annum for repairs. The price to private consumers is subject to a discount of 10 per cent.

Harwich.—The company light, extinguish, clean, and repair. The town paints the lamp posts.

Hertford.—Lamps lighted and extinguished according to a table. No lamps lighted at full moon, nor on two nights before full moon. They are also extinguished at ten o'clock on the first and second nights, and at eleven on the third and fourth nights after full moon. No quantity specified in the contract, so that a consumption of 5ft. an hour has been assumed.

Horsham.—The lamps are lighted from sunset to sunrise, from the 1st September to the 30th April.

Huddersfield.—The 43rd section of the Huddersfield Gas Act, 1861, limits the price of gas to 4*s.* per 1000ft. within a radius of — miles from the Market Cross, and to 5*s.* beyond this radius; and provides that, after the expiration of existing contracts, the price to be charged for gas supplied to the public lamps within the limits of the Huddersfield Improvement Commissioners, shall not exceed 2*s.* 6*d.* per 1000ft. (*See* Coventry). The gas, when tried by me in Feb., 1861, had an illuminating power of twelve sperm candles, while, at neighbouring works and in the surrounding towns, with the exception of Wakefield, the gas at the same time ranged from thirteen to more than fifteen candles. In the Huddersfield Act of 1861, Parliament has fixed the standard at fourteen sperm candles.

Hull.—The price paid is £4 10*s.* in the east district, and £3 15*s.* in the old town, Myten, and Sculcoates. The town is lighted by three companies.

Inverness.—The price has lately been settled by arbitration, when it was reduced from 8*s.* for eighteen candle gas to 7*s.* 6*d.* for twenty-five candle gas, being equivalent to a saving of 30 per cent. Subsequently, the price was reduced to private consumers from 8*s.* 4*d.* to 7*s.* 6*d.* for the same improved quality, being a saving to consumers of 36 per cent.

Ipswich.—The price to the private consumer has lately been reduced from 5*s.* 6*d.* to 4*s.* 6*d.* per 1000 feet.

Kilmarnock.—The price to private consumers is subject to discounts up to 10 per cent.

Lancaster.—The price to private consumers has lately been reduced from 5*s.* 6*d.* to 5*s.* per 1000ft.

Leeds.—The lamps are lighted according to a table. The price to private consumers lately reduced from 4*s.* 6*d.* to 3*s.* 9*d.* per 1000ft.

Leicester.—The lamps are lighted according to a table, and the consumption ascertained by means of meters. The price paid by contract for gas in the public lamps is 3*s.* 11*d* per 1000ft., with a discount of 5 per cent. The price to private consumers has lately been reduced from 4*s.* 8*d.* to 3*s.* 11*d.* per 1000ft.

Lichfield.—The lamps are lighted on the average six hours each night, from the first Saturday in September to the last in April, excepting nine nights at each full moon. There is no stipulation in the contract as to quantity. The price to the private consumer has lately been reduced from 6*s.* to 5*s.* per 1000ft., and is now somewhat lower than that paid for the gas in the public lamps!

Lincoln.—The price paid by contract is 4*s.* per 1000ft. for gas consumed in the public lamps. The consumption is ascertained by meter, and is found to average $3\frac{3}{4}$ft. an hour.

Liverpool.—The price paid for the public lamps here is calculated at the same rate per 1000ft. as that paid by the private consumer, with an addition of 17*s.* 3*d.* for lighting, extinguishing, and repairing, the town painting the lamp posts. When this amount is reduced to a proper charge, it makes the price paid for gas alone in the public lamps of Liverpool more than that paid by the private consumer. This is a very unusual and exceptional circumstance, which injures the ratepayers who are not gas consumers for the benefit of those who are.

Luton.—The lamps, according to the contract, are to be lighted from dusk till daybreak, which, being somewhat indefinite, I have assumed equivalent to ten hours a day. The price to private consumers is subject to a small discount.

Lynn.—The lamps are not lighted in June and July. During the rest of the year they are lighted from one hour after sunset to one hour before sunrise, with the following exceptions: on three nights before each full moon, on the night of full moon, and the night after, they are not lighted after midnight. On the second night after each full moon they are extinguished one hour after midnight, and, on the third night, at two hours after midnight.

Macclesfield.—The company lights and extinguishes. The town paints and repairs. The works have lately been bought by the corporation, but the particulars in the table apply to the public lighting as performed by the company up to the time of sale.

Maidenhead.—The lamps are lit from the 12th September to the 12th April, and are not lit during five nights at each full moon. The Local Board pays half the expense of lighting, extinguishing, and repairing, so that a greater deduction than 11*s.* ought to be made; and thus the price for gas in the public lamps will be lower still as compared with that paid by the private consumer. No quantity specified in contract, so that 5ft. an hour has been assumed.

Manchester.—The price paid per lamp is £1 15*s.* 4*d.*, with a discount of 5 per cent. The price to private consumers has lately been reduced from 5*s.*, with discounts, to 4*s.* with discounts, ranging up to $8\frac{1}{3}$ per cent.

Montrose.—The consumption of the lamps is determined by experiment, a practice which prevails in most Scotch towns. The lamps burn, as a rule, from sunset till 11 p.m., from 1st September to 31st March, but this time varies occasionally, 1493 being the actual time of burning during the last year.

Newcastle-under-Lyne.—The lamps are lighted from the 1st September to the 30th April, except three nights at each full moon. No quantity specified in contract, so that a consumption of five feet an hour has been assumed.

Newcastle-upon-Tyne.—The price paid is 10*d.* per lamp per week, being lighted during 8 months of the year. The cost of lighting, extinguishing, &c., is not deducted, because the Company is paid extra for this service.

Newark.—The price for public lamps has lately been reduced from £2 10*s.* to £2 4*s.* per lamp. The price to private consumers has also been reduced from 5*s.* with discounts, to 4*s.* 2*d.* per 1000ft.

Northampton.—The price for the public lamps has been settled from time to time by arbitration under the Northampton Improvement Act. The price to large private consumers is subject to a discount of 10 per cent.

Northwich.—The public lamps are lighted only from 1st September till the 30th April.

Norwich.—The private consumer is entitled to a discount of 5 per cent. when his account for gas amounts to £50 per annum.

Nottingham.—The company light and extinguish. The Town Lighting Committee paint and repair. The lamps are lit, on an average, 10 hours per night throughout the year.

Oldham.—The price to private consumers has lately been reduced from 4*s.* 6*d.* to 4*s.* per 1000ft. The present price is 4*s.*, with discounts down to 3*s.* 4*d.*

Otley.—The whole number of public lamps in Otley is 70. The consumption is ascertained by means of meters attached to four of the lamps. The average consumption in the year 1860 was 5214 cubic feet. The lamps are generally not lighted during seven nights at each full moon. Still the quantity consumed, as ascertained by meter, seems to be remarkably small.

Paisley.—The same price is paid for gas in the public lamps as that paid by the private consumer. The price for both has lately been reduced from 5*s.* to 4*s.* 7*d.* per 1000ft. The gas is of very high illuminating power, probably twenty-six candles. If the street lamps in London were charged at the same rate as in Paisley, they would cost only £1 15*s.* instead of £4 15*s.* per lamp per annum.

Perth.—There are 265 public lamps, the consumption of which is calculated according to the registration of meters attached to ten out of the whole number. The lamps consume from $1\frac{1}{2}$ft. to 2ft. an hour. In consequence of dissatisfaction on the part of the consumers, the company offered to reduce the price to 5*s.* 10*d.* in May, 1862; but this offer having been rejected, they have since consented to reduce the price to 5*s.* from the 11th November, 1861.

Portsea.—The lamps are lit from one hour after sunset to one hour before sunrise throughout the year. No specification in contract as to quantity, so that a consumption of 5ft. has been assumed. The company light and extinguish the lamps, but the repairs are done by the local authorities. The same remarks apply to Portsmouth, except that there the lamps are lit throughout the year from sunset to sunrise. In the Portsea Gas Act of 1861, the local authorities are entitled to burn by meter, with a proportion of one meter to twenty lamps.

Plymouth.—The lamps burn from one hour after sunset to sunrise on the following morning. The price has lately been reduced to the private consumer from 4*s.* to 3*s.* 4*d.* per 1000ft., without any corresponding reduction in the public lighting, so that the net price of gas consumed in the public lamps is now somewhat in excess of that paid by the private consumer. The consumption of public lamps has been ascertained by means of six meters.

Preston.—The price to private consumers subject to discounts varying from 10 to 30 per cent., if accounts paid within a month after delivery.

Reading.—This town is unfortunately the victim of two companies, who each charge the private consumer 6*s.* per 1000ft. for his gas, with a reduction to 5*s.* 6*d.* when the consumption exceeds 20,000ft. a year. All consumers are further entitled to a discount of 6*d.* per 1000ft. for cash payments. The lamps burn by contract from half an hour after sunset to a quarter of an hour before sunrise. One-third of the lamps are lighted all the year round; the other two-thirds are not lighted from 4th May to 31st August, nor on three nights at each full moon. The Local Board paints the lamp posts. The particulars in the table are those which prevailed up to Michaelmas, 1861, but the whole subject is now in dispute.

Rochdale.—The works belong to the corporation. Private consumers are allowed discounts according to consumption, which reduce the price in some cases to 3*s.* 3*d.* per 1000ft. The gas, when tried by me in February, 1860, had an illuminating power equal to 20 sperm candles.

St. Ives.—The consumption of gas consumed by the public lamps is ascertained by means of a meter attached to one lamp in twelve.

St. Neots.—In the table the price paid for gas in the public lamps appears to be greater than paid by the private consumer. The price of 7*s.* 3*d.*, however, should be somewhat reduced, as some of the lamps burn all night during a portion of the year. Others only burn during a portion of the year from 5 till 11 P.M. The time of 792 hours is taken from the return by the local authority. The return also states that, although meters have not hitherto been used for the public lamps, they are to be employed after Michaelmas, 1861.

Salford.—The works here belong to the corporation. The price of the private consumer has lately been reduced as follows:—

	Within the borough.	Outside the borough.
Former price	4*s.* 6*d.* to 4*s.*	5*s.* 0*d.* to 4*s.* 6*d.*
Present price	3*s.* 10*d.* to 3*s.* 6*d.*	4*s.* 4*d.* to 4*s.*

The price for the public lamps has also lately been reduced from 12*s.* 6*d.* to 10*s.* per 1000 hours. The gas at Salford, when tested by me in March, 1861, had an illuminating power of $16\frac{1}{4}$ sperm candles.

Salisbury.—One hundred and fifty-five lamps are lighted from 14th September to 19th April, sixty-nine from 19th April to 1st May, fifty-one from 1st May to 1st September, and sixty-nine from 1st September to 14th September. All are lighted from sunset to sunrise, except nine nights at each full moon. These times give an average period of 1105 hours per annum for each lamp. The company light, extinguish, and paint the lamps only, and repair the glass only. Consumption of lamps determined by meter.

Scarborough.—Certain lamps burn all night, and are lit about 3600 hours per annum. Other lamps are extinguished at midnight, and burn about 1400 hours per annum. The contract price is 4*s.* per 1000ft. of gas consumed in the public lamps. The gas company charge the extravagant price of £1 a lamp for lighting, painting, repairs, use of lamps, &c.; but as the net price charged for gas alone is 4*s.* per 1000ft., I have only used this in the table.

Sheffield.—The price has lately been reduced to private consumers from 4*s.* with discounts, to 3*s.* 9*d.* with discounts up to 20 per cent., so that some consumers are charged only 3*s.* per 1000ft. Under these circumstances, the price paid for public lighting is too high. The gas at Sheffield, when tested by me in April, 1860, had an illuminating power of only nine sperm candles, being the worst gas which I found in any part of Yorkshire. In the small town of Pontefract the gas at the same time had an illuminating power of $13\frac{1}{2}$ sperm candles. In fact, there is so much Cannel coal in Yorkshire that it is by no means difficult to maintain a standard of 14 sperm candles, which is the one Parliament has insisted on in most of the Yorkshire Acts during the last session.

South Shields.—The price paid is 1*s.* $2\frac{1}{2}$*d.* per lamp per week. The lamps are lighted from the 7th August to the 15th May. They are not lighted at all on the night of full moon, nor on three nights preceding. On the first night afte each full moon they are extinguished at 9 P.M., on the second night at 10 P.M., and on the third night at midnight. The company light and extinguish the lamps, the town paints and repairs. No quantity for consumption is specified in contract, so that 5ft. an hour has been assumed.

Shrewsbury.—The price to private consumers is subject to discounts up to 20 per cent., and the railway companies are charged only 3*s.* 6*d.* per 1000ft. The price for gas in the public lamps has been fixed by arbitration under the Shrewsbury Improvement Act at 3*s.* 4*d.* per 1000ft., and this is the real price paid, assuming 17*s.* 6*d.* as the cost of lighting, cleaning, &c., and for use of lamps. The real value of this, however, is not more than 16*s.*, so that the price for gas alone appears in the table somewhat higher per 1000ft. than that fixed under the arbitration.

Sunderland.—The corporation paints and repairs. Lamps only lighted during nine months of the year.

Swansea.—The price to private consumers has lately been reduced from 5*s.* and 4*s.* 6*d.* to an uniform price of 4*s.* per 1000ft. The Swansea Gas Act, 1861, limits the price to 4*s.* within and 5*s.* 6*d.* without the borough.

Tamworth.—The lamps are lighted from 1st September to 30th April. They burn from dusk till 4.30 in the morning, with exceptions at full moon. No quantity specified in contract, so that a consumption of 5ft. an hour has been assumed.

Tavistock.—Lamps lighted all the year round except on four nights at each full moon. No quantity specified in contract.

Torquay.—In this case there is no contract, the Local Board burning by meter, and paying by the 1000ft. just as any private consumer. The consumption is ascertained by one meter in 12 affixed to the public lamps, and this is said by registration of the meters to be in reality 5ft. an hour. The gas at Torquay, when tried by me in March, 1860, had an illuminating power of only 8½ candles.

Totnes.—The company light and extinguish only. The return from the local authority states that the lamps burn by contract from 12 to 13 hours per night; but as this would require the lamps to burn a considerable part of the day as well as of the night, the lamps are assumed to burn between sunset and sunrise only. No quantity specified in contract. It appears Totnes is lighted by two companies, which probably do not compete, as they each charge the extravagant price of 6*s.* 3*d.* per 1000ft.

Tottenham.—The company light and extinguish. The Local Board paints and repairs. The lamps are only lighted during nine months of the year. The private consumers are charged 6*s.* per 1000ft., with a discount of 6*d.* if paid within a month.

Tynemouth.—The return for this place includes North Shields, which forms part of the borough of Tynemouth. The company light and extinguish, the town paints and repairs. No quantity specified in contract.

Uxbridge.—The price per lamp in the in-ward is £2 15*s.*, and in the out-ward £3 per annum. In the in-ward the lamps are lighted all the year round, from sunset to sunrise, except on three nights at each full moon. In the out-ward the lamps are lighted only from 1st September to 30th April, with the same exceptions at full moon. The price paid by private consumers is 5*s.* 6*d.* within a mile from the town, and 7*s.* per 1000ft. beyond that distance. Gas by act of 1861 to be 12 candle gas.

Wakefield.—The price paid for public lamps is based on the same net charge for gas as to the private consumers, with an addition of 7*s.* 6*d.* per lamp for lighting, cleaning, and extinguishing. The Town Council, however, have discovered by experiments on 91 of the lamps that they only burn on the average 2·23 instead of 4ft. an hour. They, therefore, wish to contract for only 3ft. an hour, which is nearly what they receive at present, and of course they expect a corresponding reduction of price. The gas at Wakefield is below the average of most Yorkshire towns, and when tried by me in February last had an illuminating power of only 10½ sperm candles.

Wallingford.—The company light and extinguish, the town paints and repairs. The return states 3 to 5ft. as the consumption per hour of the public lamps, according to contract. I have, therefore, assumed 4ft. as the mean. The private consumer is entitled to 10 per cent. discount for prompt payment. The gas, when tried by me in Feb., 1860, had an illuminating power exceeding 13 sperm candles.

Walsall.—The works belong to the corporation. The prices to private consumers range from 3*s.* 4*d.* down to 2*s.* 10*d.*, according to consumption. The gas, when tried by me in February, 1860, had an illuminating power of only nine sperm candles; but one of the Birmingham companies, whose works are at West Bromwich, were just beginning to compete with the corporation of Walsall, and were supplying gas at the same time equal to nearly thirteen sperm candles.

Warrington.—The return states that the quantity consumed by the public lamps has been determined by experiment at 3ft. an hour. The price to the private consumer is subject to a discount of 10 per cent. if paid within a month.

Warwick.—The lamps are lighted during April, August, September, and October, from half an hour after sunset to 3 A.M. In March, from half an hour after sunset to 4 A.M. In November, from sunset to 4 A.M. In December, January, and February, from sunset to 5 A.M. In May, from 9 P.M. till 2 A.M. During June and July, and during seven nights at each full moon, they are not lighted at all. There is no specification in the contract as to quantity per hour. The price of gas to private consumers has lately been reduced; but is still very high, namely, 6*s.* to consumers under 1000ft. per quarter, and 5*s.* 6*d.* to consumers of more than this quantity, with a deduction of 6*d.* per 1000 from each price if paid within a month after the quarter day.

Watford.—The lamps are lighted from sunset to sunrise during eight and a half months, namely, from 16th August to 1st May. The works are leased by a contractor, who refuses to be bound by any stipulation as to quantity. A consumption of 5 feet an hour has been assumed.

Wellington.—The company light, extinguish, and repair, but the town paints the lamp posts. There appears to be no stipulated consumption in the contract, but the return states that the lamps are calculated to consume from 4ft. to 5ft. an hour. An average consumption of 4½ft. has therefore been assumed.

Wells.—The lamps burn from sunset to sunrise throughout the year, except on five nights at each full moon.

West Ham.—This return applies to the whole parish of West Ham, which includes Stratford, Plaistow, and Upton. The lamps burn throughout the year from an hour after sunset to an hour before sunrise. The exceptional high price paid here shows that West Ham comes within the influence of the metropolitan companies, who all charge much higher rates for public lighting than those which prevail in the provinces.

Weymouth.—The price paid is £2 per lamp for ten months in the year, namely, from the 2nd of August to the 31st of May, and 2*s.* 6*d.* per lamp per month for June and July. The lamps are lighted as follows:—Between 1st November and the end of February, from sunset to sunrise; between 1st March and the end of May, from one hour after sunset to the second hour before sunrise; between 1st August and the end of October, during the same hours, except on five nights at each full moon; in June and July, during the same hours, except on eleven nights at each full moon. The contract specifies a consumption of 5ft. an hour, but, according to the return, not more than 3ft. or 4ft. are really supplied.

Winchester.—The prices paid are £1 10*s.* per lamp for the summer five months, and £2 10*s.* for seven winter months. In summer, every alternate lamp only is lighted. The lamps burn from one hour after sunset to one hour before sunrise, except that one-half are not lighted on five nights at each full moon.

Wisbech.—The lamps are not lighted at all during June and July, and during the rest of the year are lighted from one hour after sunset to one hour before sunrise, with the following exceptions at full moon:—On the night of each full moon, and on the three nights immediately preceding the same they are not lighted at all. On the night succeeding each full moon, lighted from one hour after sunset until midnight. On the second night after each full moon, lighted from one hour after sunset until one hour after midnight. On the third night after each full moon, lighted from one hour after sunset until two hours after midnight.

Worthing.—The lamps are paid for by meter; the consumption being ascertained by meters attached to four of the lamps. The Local Board light and extinguish, and repair the glass of the lamps; the company paint and repair. The lamps burn from sunset till half-past two in the winter, and till 1 A.M. in the summer. The price for the public lamps is settled every seven years by arbitration. Under an arbitration which has just taken place, the price to private consumers is to be reduced to 6*s.* 3*d.* per 1000 feet, and that for public lamps to 4*s.* 8*n.* per 1000 feet.

Wrexham.—The price paid is 7*s.* per lamp per month from 1st March to 31st August, and 4*s.* 7*d.* per lamp per month from 1st September to 28th February. For painting and repairing the company are paid 8½*d.* per lamp per month. The lamps are lighted throughout the year, except during five moonlight nights in each month.

STRENGTH OF MATERIALS.

DEDUCED FROM THE LATEST EXPERIMENTS OF BARLOW, BUCHANAN FAIRBAIRN, HODGKINSON, STEPHENSON, MAJOR WADE, U.S. ORDNANCE CORPS, AND OTHERS.

BY CHARLES H. HASWELL, C.E.

(*Continued from page* 276.)

(From the *Journal of the Franklin Institute.*)

CRUSHING STRENGTH.

The Crushing Strength of any body is in proportion to the area of its section, and inversely as its height.

Experiments upon cast iron bars give a crushing stress of 5000 lbs. per square inch of section, as just sufficient to overcome the elasticity of the metal; and when the height exceeds three times the diameter, the iron yields by bending.

When the height of a prism or column is not five times its side or diameter, the crushing strength is at its maximum.

When it is 10 times	it is	reduced as	1·75	to 1.
15	,,	,,	2·	to 1.
20	,,	,,	3·	to 1.
30	,,	,,	4·	to 1.
40	,,	,,	6·	to 1.

In tapered columns, the strength is determined by the least diameter.

The experiments of Mr. Hodgkinson have determined:—

The resistance to fracture from flexure in long columns of like dimensions is about three times greater when the ends of the columns are flat and firmly bedded, than when they are rounded and capable of being diverted from their vertical position.

An increase of strength of about ⅐ to ⅛ of the breaking weight is obtained by enlarging the diameter of a column in its middle.

In cast iron columns of the same thickness, the strength is inversely proportional to the 1·7 power of the length, nearly. Thus,

In solid columns, the ends being flat, the strength is as $\frac{d^{3\cdot6}}{l^{1\cdot7}}$, l representing the length, and d the diameter.

In hollow columns having a greater diameter at one end than the other, or in the middle than at the ends, it was not found that any additional strength was obtained over that of uniform cylindrical columns.

The strength of a column in the form of that of a connecting rod of an engine was found to be very low, being less than half the strength that the same metal would have given if cast in the form of an uniform hollow cylinder—the ratio being as 175 to 396.

The strength of a column irregularly set, the pressure being in the direction of its diagonal, is reduced to $\frac{1}{3}$ of its strength when the pressure is vertical.

In rectangular columns, the length and quality of the material being the same, the square gives the highest strength.

With cast iron, a pressure beyond 12 tons per square inch is of little if any use in practice.

For equal decrements of length, wrought iron will sustain double the pressure of cast iron.

Glass and the hardest stones have a crushing strength from seven to nine greater than tensile; hence an approximate value of their crushing strength may be obtained from their tensile, and contrariwise.

A hollow column of cast iron, 10in. in diameter, and but $\frac{5}{4}$in. thick, may be extended to 12·5ft. in height, and possess the same resistance as a solid column of like weight, 6·5in. in diameter and but 7·5ft. in height.

Table of the Crushing Strength of various Materials.

Deduced from the Experiments of Major Wade, Hodgkinson, and Captain Meigs U.S.A., and reduced to an uniform measure of 1 *square inch.*

FIGURES AND MATERIALS.	Side or diameter.	Height.	Crushing weight.
CAST IRON PRISMS:	Inches.	Inches.	lbs.
American, gun metal	·6	1·5	147,803
,, mean	·6	1·5	129,000
English Low Moor, No. 1	1·	1·	62,450
,, ,, ,,	1·25	2·	63,640
,, ,, No. 2	·75	1·5	92,330
,, Clyde No. 3	·75	1·5	106,039
,, Calder No. 3	·75	1·5	101,000
,, Stirling* No. 2	·75	1·5	119,550
Mean of all	·75	1·5	122,395
Extreme	1·	1·5	134,400
WROUGHT IRON PRISMS:			
American, mean	1·	1·	83,500
English	1·	1·875	65,200
METAL PRISMS:			
Fine Brass	1·	1·	164,800
Cast Copper	1·	1·	117,000
Wrought ditto	1·	1·	103,000
Cast Tin	1·	1·	15,500
Lead	1·	1·	7,730
CAST STEEL:			
Soft	...	...	198,944
Tempered	...	...	373,041
ditto mean	...	...	295,000
Tungsten	...	...	155,916

FIGURES AND MATERIALS.	Width.	Thickness.	Area.	Crushing weight.
WROUGHT IRON PLATES:	Inches.	Inches.	Inches.	lbs.
Length 10ft.	2·98	·497	1·48	815
,, 10ft.	3·01	·766	2·30	3,379
,, 7ft. 6in.	1·02	1·025	1·05	9,752
,, 5ft.	1·02	1·024	1·05	17,267
,, 2ft. 6in.	1·02	1·024	1·05	25,327
,, 1ft. 3in.	1·02	1·023	1·05	34,555
HOLLOW CYLINDERS:	External.	Internal.		
Length 9ft. 11in.	1·495	1·292	·444	14,661
,, 9ft. 11in.	2·49	2·275	·804	29,779
,, 10ft.	2·34	1·91	1·435	22,179
,, 10ft.	6·366	6·106	2·547	35,886
RECTANGULAR TUBES:				
Length 10ft., lap riveted	4·1	4·1	·504	10,980
,, 10ft. ,,	4·1	4·1	1·020	19,261
,, 10ft. ,,	4·25	4·25	2·395	21,585
,, 10ft. ,,	8·4	4·25	6·890	29,981
,, 10ft. ,,	8·1	8·1	2·070	13,276
,, 10ft. ,, and with two internal diaphragm plates	8·1	8·1	3·551	19,800

* Cast and Wrought Iron Mixed.

MATERIALS.	Diam.	Height.	Crushing weight.
CAST IRON—*Solid Cylinders:*	Inches.	Inches.	lbs.
English Low Moor, No 3, Dry Sand	·5	60·5	730
,, ,, ,,	1·	60·5	2,423
,, ,, ,,	1·96	60·5	8,097
,, ,, Green sand	·5	60·5	2,485
,, ,, ,,	1·	60·5	8,061
,, ,, ,,	·51	20·16	1,914
,, ,, ,,	·5	12·1	3,595
,, ,, ,,	·52	2·	11,433
,, ,, ,,	·52	1·	12,308
CAST IRON—*Hollow Cylinders:*	External diam.	Internal diam.	
English Low Moor, No. 3; height 7ft. 6·75in. Dry Sand	1·75	1·21	31.298
	1·99	1·31	39,804
	2·23	1·54	58,796
WOODS:	Diam.	Height.	
Oak, American	1	1	4,100
,, Canadian	1	2	5,982
,, English	1	2	9,500 6,484
Yellow Pine	1	2	5,375
Ash	1	2	8,663
Beech	1	2	9,363
Cedar	1	2	5,768
Elm	1	2	10,331
Box	1	2	9,265
Mahogany, Spanish	1	2	8,198
Sycamore	1	2	7,082
Walnut	1	2	6,645
Teak	...	...	12,100
STONES, &c.:			
Granite, Patapsco	1	1	11,200
Sandstone, Aquia Creek*	1	1	5,340
,, Seneca†	1	1	10,764
,, Aquia Creek, strata laid horizontally	1	1	8,332
Marble, Stockbridge‡	1	1	10,382
,, East Chester§	1	1	23,917
,, Symington, large crystals‖	1	1	11,156
,, ,, strata horizontal	1	1	10,124
,, ,, strata vertical	1	1	9,124
,, ,, fine crystal	1	1	18,248
,, Italian	1	1	12,624
,, Lee, Mass.	1	1	22,702
,, Hastings, N. Y.	1	1	18,941
,, Montgomery co., Pennsylvania	1	1	8,950
,, Baltimore, large crystal	1	1	8,057
,, ,, small crystal	1	1	18,061
Freestone, Belleville	1	1	3,522
,, Connecticut	1	1	3,319
,, Dorchester	1	1	3,059
,, Little Falls	1	1	2,991
,, Caen	1	1	1.088
Gneiss	1	1	19.680
Brick, hard	1	1	4,368 2,000
,, common	1	1	4,000 800
English Craigleith Limestone	1	1	5,600
,, ,, Sandstone	1	1	31,449
,, Arbroath	1	1	7,884
,, ,, Stone	1	1	8,270
,, Caithness	1	1	6,493
,, Portland	1	1	15,583 4,570
,, Aberdeen Granite	1	1	8,400 10,363
,, Portland Oolite	1	1	3,850
,, Limestone	1	1	3,065
,, Portland Cement, mean	1	1	8,300
Adelaide Sandstone	1	1	2,800
Sydney ,,	1	1	2,228
Normandy Caen	1	1	1,543
Portland Cement 1, Sand 2	1	1	8,100
,, 1, ,, 3	1	1	5,000
,, 1, ,, 4	1	1	5,900
,, 1, ,, 6	1	1	8,400
Fire Brick, English	1	1	2,442
,, Stourbridge	1	1	1,717
Stock Brick	1	1	2,177
Red Brick	1	1	807
Marble	1	1	6,431

* Same as that of the Capitol, Treasury Department, and Patent Office, Wash., D.C.
† Same as that of the Smithsonian Institute.
‡ Same as that of the City Hall, New York.
§ Same as that of the General P. O. Wash.
‖ Same as that of the National Wash. Mon

Comparative Strength of Cast and Wrought Iron to bear Compression in the Direction of their Length.

Dimensions of Bar 1in. square and 10ft. in length.

DECREASE IN LENGTH.

Weight.	Cast Iron.	Wrought Iron.	Weight.	Cast Iron.	Wrought Iron.
lbs.	Inches.	Inches.	lbs.	Inches.	Inches.
5,054	·054	·028	27,498	·300	·143
9,578	·102	·052	29,738	...	·154
11,818	·126	...	31,978	·357	·174
14,058	·151	·073	40,938	·503	...
23,018	·247	·119	54,378	·865	...

Resistance of Cast and Wrought Iron Bars to Compression, Laid Vertically.

1in. square, and 10ft. in length, enclosed in an Iron Frame, to maintain them in a vertical position.

CAST IRON.

IRON.	Weight applied.	Extension.	Set.
	lbs.	Inches.	Inches.
Low Moor, No. 2	2,100	·0230	·00100
" "	4,200	·0442	·00325
" "	8,401	·0884	·00862
" "	16,802	·1773	·02125
" "	33,604	·3810	·07262
Blaenarvon, No. 2..................	2,032	·0191	...
" "	4,064	·0391	·00187
" "	8,125	·0791	·00483
" "	16,257	·1618	·01775
" "	32,514	·3439	·06270
Mean of four kinds	2,064	·0187	·00047
" "	4,129	·0388	·00226
" "	8,258	·0788	·00645
" "	16,517	·1634	·01712
" "	33,030	·3534	·06096

WROUGHT IRON.

Ultimate Practical Resistance.

Mean weight, 26,933 lbs.; mean compression, ·139in.

Hence, the length of the bars being 10ft. = 120in. $\frac{120}{\cdot 139} = 863$; consequently, a wrought iron bar will bear a compression of $\frac{1}{863}$ of its length, without its utility being destroyed, although its elasticity will be materially injured.

(To be continued.)

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

CURRENT TOPICS.

BY WM. TITE, ESQ., M.P., *President*.

(Continued from page 283.)

Sir F. Palgrave was born in the year 1788, and died 6th July, 1861. Sir F. Palgrave rendered great service to the cause of archæology and to our knowledge of the political and moral condition of our Saxon and Anglo-Norman ancestors. It may appear to casual observers that this class of researches has but little reference to our professional pursuits, yet if we reflect upon the intimate relations which must exist between the social organization of a nation, and its mode of artistic expression we must be convinced that it is impossible to understand the latter without being intimately acquainted with the former. In these days of revival of Mediævalism, therefore, it is essential for us to be well informed of the ruling principles of the times we are called upon artistically to repeat; and few men have been more successful than was Sir F. Palgrave in his descriptions of the manners and customs, or more correct in his accounts of the social organization of our ancestors.

The knowledge of the more abstruse parts of the Science of Natural Philosophy applied to our profession has been so much advanced by the distinguished men I have cited amongst our recent losses, that we may well devote some time to a review of their works. Thus, to M. Wertheim (who was born at Vienna on 6th May, 1815, and died at Tours, 19th January, 1861) we are indebted for some important investigations in the laws of elasticity, and of the sonorous vibrations of air and gases. In 1846 M. Wertheim published a mémoire, written in conjunction with M. Chevandier, "upon the mechanical properties of wood," which, unfortunately, has not yet been translated into English; and in a mémoire "upon the double refraction produced in isotropous bodies" M. Wertheim discussed the results obtained by Mr. Hodgkinson from his experiments upon the elastic conditions of cast and wrought iron, suggesting for the purpose of observing the gradual effects of compression of solid bodies the elegant chromatic dynamometer. This mémoire will be found in the "Annales de Chimie et de Physique."

The name and works of Vicat are of course known to all who have followed the history of modern science. Engaged in early life in the actual practice of his duties as engineer of the Ponts et Chaussées, he constructed some of the roads leading to Genoa on the banks of the Isle river, in the Perigueux; and in 1813 he was appointed engineer to the Bridge of Souillac, over the Dordonne, and it was in the course of the preliminary studies for this work that he was led to the discoveries which have so materially advanced the building arts and immortalised his name. At Souillac, Vicat introduced the system of founding the piers of bridges on masses of concrete, sunk under water within close piled enclosures, or "caisses sans fonds," and to secure the success of the system it was necessary that he should use a lime which should be capable of setting under water. The chemical theory of limes and cements was at that period but very little understood, though the researches of Smeaton, Higgins, Guyton de Morveau, Bergman, and de Saussure, and the introduction by Wyatt of the Roman cement, had placed at the disposal of inquirers many of the elements of its solution. About 1817, Vicat communicated to the Academie des Sciences the results of his analytical and synthetical experiments upon the composition of limes of various qualities; and he then propounded the theory which subsequent inquiries have confirmed and developed, to the effect that the hardening of mortars depended on the combination which takes place in them between the lime and the silicate of alumina they contained. Vicat published in some separate brochures the results of his subsequent experiments, and in the Annales des Ponts et Chaussées he has also published some important mémoires on the strains to which suspension bridges are exposed, on the resistance of iron wire ropes, on the compression of solid bodies and on the statistics of the lime producing formations of France. He co-operated with M. St. Leger in the introduction of the manufacture of the artificial hydraulic limes, and indeed he must be considered to have led the way to all the modern improvements in that important branch of the building arts. M. Vicat was fortunate enough to witness the universal recognition of the truth and of the practical importance of his discoveries, which, with the true spirit of a philosopher, he had at once unreservedly placed at the service of the public. He received honours from every government which in turn has ruled in France during his long and useful career, and in 1845 the legislature of his country unanimously voted him a pension of 6000 francs a year, on the strength of a report presented by MM. Arago and Thénard. When in 1853 Vicat resigned his post on account of his advanced age, he was named by a special decree of the Emperor, Honorary Inspector-General of the Ponts et Chaussées, a dignity created expressly to honour this earnest and disinterested student. Vicat's works have been translated into almost every language of Europe; into our own, by Captain E. H. Smith. Vicat died on 10th April, 1861, aged 75 years.

In the course of this year also, the ranks of science have lost M. Berthier, the distinguished author of the "Traité des Analyses par la voie sêche," in the course of which will be found some chapters bearing upon our profession. Berthier devoted, in fact, much attention to the examination of Vicat's discoveries, and has discussed the principles on which they are founded; he also paid attention to the analytical inquiries into the nature of other building materials, and of the metals used in construction. Berthier died 24th August, 1861.

We have to regret also the loss of Sir Charles Pasley, whose name has been so intimately connected with the diffusal in our country of the inventions and theories of Vicat. Sir Charles was born in 1781, and in 1797 he entered the army as second-lieutenant of artillery, but in the next year he exchanged into the Royal Engineers. He served at the defence of Gaeta, in 1806; at the Battle of Maida; at the Siege of Copenhagen; as Aide-de-Camp to Sir J. Moore, in 1808-1809. In the Walcheren Expedition, Sir Charles, then Captain Pasley, was wounded twice; he then served in the Peninsular War until 1812; and in 1813, he was appointed Director of the Royal Engineers' Establishment, at Chatham, a post he retained until his nomination as major-general in 1841. The connection of General Pasley with our profession is to be sought principally in the various papers inserted by him in the Corps papers of the Royal Engineers; in his "Observations on Limes and

Calcareous Cements," 8vo., London, 1838; in the interesting operations for the removal of the wreck of the *Royal George*, and in blasting the Round Down Cliff, near Dover; indirectly, his duties as Inspector of Railways also brought General Pasley in contact with some of the members of our profession. Perhaps I may be allowed especially to call attention to the part which Sir Charles bore in the introduction of the artificial, overcalcined cements, known at the present day by the name of the Portland cements. In this instance, Sir William worked in connexion with the late Mr. Frost, and those gentlemen seem only to have missed the discovery of the influence of excessive calcination upon the action of the slow setting cements, in their curious and valuable researches. General Sir Charles Pasley died on the 19th April, 1861.

Mr. Eaton Hodgkinson was one of the students of the abstruser branches of science connected with our profession, whose labours will long continue to influence its practical details, and he may also be cited as one of those who achieved distinction by his "self-help," even while following studies of the most recondite order. Without any adventitious aids from family connexion, or of wealth, Mr. Hodgkinson had succeeded in making himself sufficiently known for his acquaintance with the application of the higher branches of mathematics to the physical sciences (especially by the publication of a paper, in the Memoirs of the Manchester Society for 1822), to be employed by the engineers of that very practical town to conduct some experiments on the strength of cast-iron, and on the best form of section to be adopted for girders. Previously to the publication of Mr. Hodgkinson's inquiries, the rules laid down by Tredgold on these subjects had been universally received by practical men; and he reasoned upon the supposition that cast iron, like other solid bodies, resisted equally the force of compression, exercised upon the top or upon the bottom, when loaded as a beam. Tredgold therefore inferred that the best form of section would be one resembling the letter I, with equal flanges at the top and at the bottom. Hodgkinson, however, discovered that cast iron presented some anomalous conditions of elasticity, and that especially it resisted efforts of compression with an energy which was nearly six times as great as the energy with which it resisted efforts of extension; he was thus led to recommend a form of cross section for girders in which the upper and lower flanges were made to present sectional areas corresponding with the efforts of compression and of extension they would respectively have to resist. The late George Stephenson was one of the first engineers to adopt this form of girder, for the bridge on the Liverpool and Manchester railway, over Water-street, Manchester, erected in 1830; since then it has been adopted universally, though for my own part I confess that the unequal rates of cooling in the top and bottom flanges of Mr. Hodgkinson's form of girders seems to me to involve a very serious practical danger, on the score of the soundness of the casting in which the areas of the flanges are so markedly unequal.

Mr. Hodgkinson then devoted his time and attention to a series of investigations into the general laws of the elasticity of rigid bodies, and of the strength of pillars of cast iron and of other materials. His methods of observations were far from being as elegant or refined as those adopted by M. Wertheim, but they have been made more practically useful, and the empirical formulæ deduced from them still regulate the practice of engineers and architects. Mr. Hodgkinson's results were published in the Transactions of the Royal Society in 1840, and they were judged worthy to secure their author the Royal Gold Medal, and his nomination as a member of that learned body. In 1845 Mr. Hodgkinson was engaged by Mr. Robert Stephenson, in conjunction with Mr. Fairbairn, in the experiments it was considered necessary to make previously to constructing the tubes of the Conway and of the Britannia bridges; and it is to the results so obtained that we are indebted for the wonderful change introduced in the building arts by the application of wrought iron, plain, and boxed girders. The most important facts thus elicited by Mr. Hodgkinson were communicated by him to the "Commissioners to inquire into the application of iron to railway structures" named in 1847, in consequence of the failure of the Dee bridge at Chester, and were published by them in their report. In the fourth report of the British Association is inserted a paper by Mr. Hodgkinson on the "Collision of Imperfectly Elastic Bodies," and on "Impact upon Beams;" in 1842-46 he also published a second edition of "Tredgold on the Strength of Cast Iron;" and from time to time he inserted various other scientific papers in the Transactions of the British Association, of the Royal Society, and of the Literary and Philosophical Society of Manchester. It would be very desirable to collect and arrange, in systematic order, these various detached essays.

Mr. Hodgkinson was born on the 29th February, 1789, and died on 18th June, 1861.

Sir William Cubitt was, perhaps, more immediately connected with our profession than the other eminent men hitherto noticed, on account of his connexion with the original Crystal Palace. Sir William was the son of a miller, of Dilham, in Norfolk, and at an early age he was apprenticed to a joiner; after some years, spent in the exercise of his trade and in the works required for repairing the mills of the district in which he was educated, he entered the factory of Messrs. Ransome, the agricultural implement makers and mechanical engineers, of Ipswich. In their employment, Sir William became practically acquainted with the details of civil engineering, and about this period of his life he invented the self-winding apparatus of windmills, and that important instrument of prison discipline, the treadmill. About 1826, he removed to London, and began business on his own account as a civil engineer, and, by dint of perseverance, industry, and honourable conduct, he slowly attained the foremost rank of his profession. The works executed by Sir William Cubitt on the Norfolk and Lowestoft Navigation, on the Severn Navigation, the South Eastern, and the Great Northern Railways, the landing stages at Liverpool, the new Rochester Town Bridge, the Berlin Waterworks, &c., may be referred to as illustrations of his practical genius and ability, and it is not too much to say that the manner in which the South Eastern line is carried between Folkestone and Dover, is one of the boldest pieces of engineering of which we have examples in England. In 1851, Sir William was charged with the superintendence of the working details of the Crystal Palace, and for his exertions on that occasion he received the honour of Knighthood.

Sir William Cubitt was born in 1785; he died, October 13th, 1861.

Mr. Robert Grainger, like Sir William Cubitt, furnished another illustration of the ease with which real talent and sound character may achieve distinction in our country. Grainger began in the very lowest ranks of life and even received his education in a charity school. By dint of energy, prudence, and economy, he soon raised himself above immediate want, and, having been fortunate enough to marry a lady of some fortune, he was enabled to enter upon the bold scheme of speculative building, which so changed the aspect of his native town, and, after some vicissitudes, left him a wealthy man in his later days. It would be invidious to criticise the style of building adopted by Mr. Grainger, and after all, a man should be judged, in his artistic capacity at least, by the standard of his times rather than by a comparison with the productions of more recent periods. Mr. Grainger's new streets and open spaces in and about Grey-town, in Newcastle, when judged upon these principles, must appear to be considerably in advance of the provincial street architecture of his times, and the manner in which he introduced stone instead of brick in the elevations has certainly given a monumental character to designs which, in themselves, would not have attracted much attention. The new market, exchange, theatre, dispensary, music hall, &c., of Newcastle, are works of considerable merit, and though, no doubt, Mr. John Dobson contributed much of their artistic character, it is to Mr. Grainger that the inhabitants of Newcastle are indebted for these important buildings. Mr. Grainger died 4th July, 1861, in the 63rd year of his age.

Professor Hosking, born in 1808, died 2nd August, 1861, was in his very early life apprenticed to a carpenter and builder, in New South Wales, but in 1820 he was articled to Mr. Jenkins, architect, of Red Lion-square. I believe that he took lessons in drawing of Mr. George Maddox, and after leaving Mr. Jenkins he travelled in Italy and Sicily. Some lectures on architecture, delivered at the Western Literary and Scientific Institution, led to his being engaged to write the articles "Architecture and Building," in the *Encyclopædia Britannica*, which at once established his reputation as an Architectural critic. Mr. Hosking very wisely refused to recognise the modern distinction between the professions of architect and civil engineer, and in 1834 he executed the works of what is now known as the West London Railway. Upon this line he constructed, amongst other works, a very remarkable bridge near Kensal-green, by which the canal and the common turnpike road are carried over the railway, and it may be added that in most of the foreign works on construction, this architectural piece of civil engineering has been reproduced. Mr. Hosking also designed and executed the Abney-park Cemetery, and some rather important private buildings about London, but he was most known from the fact of his having been named one of the official referees under the Building Act of 1844, and from his having filled the professorship of the principles and practice of architecture, at King's College, London. In addition to the treatises on architecture and building before noticed, Mr. Hosking published an "Essay on the Construction of Bridges," and a "Guide to the proper regulation of Buildings in Towns." Some of his lectures at the College have appeared in the columns of the *Builder* journal.

Mr. Henry Austin, formerly Secretary to the General Board of Health, and of late years Superintending Inspector of the department charged with the administration of the Local Management Act, died on 9th October, 1861. Mr. Austin was articled to Mr. R. Dixon, of Furnival's Inn, and subsequently entered the service of Mr. R. Stephenson during the construction of the Blackwall Railway. On the commencement of the sanitary movement, Mr. Austin appears to have succeeded in securing the attention of its leaders, and he was thus connected with the singular theories of sumpts, of small pipe drains, and pot-piped gathering grounds, which for so many years were forced upon the unfortunate towns who submitted to the guidance of the General Board of Health. Mr. Austin, however, was a scholar and a gentleman, and in private life he was esteemed and beloved by those who knew him.

Mr. John Clayton, the only Fellow of our Institute to whose loss I have yet referred, was known in early life by the publication of an Essay on the Churches of London, and on half-timbered houses. He settled afterwards at Hereford; but his pursuits do not seem to have been of a nature to have brought him very prominently before the general public. At least I have not been able to obtain any particulars of them, beyond the fact of his having been engaged to construct the station buildings on the Hereford and Abergavenny Railway, and some private mansions in South Wales.

Our late Fellow, Mr. George Bailey, was another of the fortunate men "who have no history." He was originally a pupil of the late Sir John Soane, and he remained for some years in the office of that eminent architect after the expiration of his articles. On the death of Sir John, Mr. Bailey was appointed Curator to the Soane Museum, and he held that post until his own death in the commencement of the spring of this year.*

Our late respected Honorary Solicitor, Mr. W. L. Donaldson, had at all times so identified himself with the interests of our Institute, and had displayed so much talent, energy, and disinterestedness in advancing its prosperity in all matters which entered into his province, that I fear we shall never be able to supply his loss. He carried us through the early period of our existence, and guided us by his friendly advice when we most needed both friends and advice. The tribute of respect we can offer to his memory, is, I fear, but a feeble consolation to those who mourn his loss, but in the sincerest and most earnest manner do I now beg to express, in the name of the whole body of the Institute, our feelings of grief and of sympathy for the loss they have sustained.

> "All heads must come
> To the cold tomb;
> But still the actions of the just,
> Smell sweet and blossom in the dust."

There were two or three other cases worthy of notice; one was the death of Mr. T. Finden, who died at the age of 77; he was a partner of Mr. Lewis, and surveyor of Hoare's brewery; the death of Mr. Woodward, the architect of the Oxford Museum, of the firm of Dean and Woodward, and who died of consumption; and the death of Zwirner, the architect for the restoration of Cologne Cathedral.

INSTITUTION OF CIVIL ENGINEERS.

November 19, 1861.
George P. Bidder, Esq., President, in the Chair.

The whole of the evening was occupied by the discussion upon Mr. Longridge's Paper on "The Hooghly and the Mutla."

It was remarked that, owing to the increased trade of Calcutta, and the insufficient accommodation for shipping in the river Hooghly, as well as of warehouse room on the bank, an inquiry had been instituted, as to whether any of the channels in the Sunderbunds could be rendered available for the relief of that port. The Mutla had been found to answer the requirements, as it possessed a safe and convenient navigation, with a tract of land suitable for warehouses and offices on its banks, within a moderate distance of Calcutta. The chief objection to the new settlement had hitherto been the unhealthiness of the site; but its salubrity would improve year by year, as embankments were being made to keep out the flood of high tides, the land was being drained, roads formed, and tanks or reservoirs excavated to hold and ensure a good supply of pure fresh water. There were numerous applicants for the land, which was sold in allotments on building lease, and there was every prospect of the new port affording a useful and necessary adjunct to Calcutta.

With a view of ascertaining what peculiar causes were in operation to make the channel of the Mutla so much deeper and more regular than that of the Hooghly, a chart of the upper part of the Bay of Bengal had been contoured. It was thus found, that there was a deep water channel in the centre of the gulf, some portions of which had not been sounded at 300 fathoms; that the water shoaled from 100 fathoms at 20 miles from the coast to 5 fathoms at 5 miles; and that the channels passing up the creeks were nearly at right angles to the line of from 30 to 50 fathoms of water. Also, that the entrance to the Multa was the nearest to the deep water; hence, there was a greater freedom of current, and the flood was carried more quickly up to the head than in the others, causing its channel to be superior to that of the Hooghly.

The most violent winds in the Bay of Bengal were from the south-west, and if accompanied with a spring tide, the littoral of Hindostan must be swept from its southern part to the mouth of the Hooghly, which lay open to receive it, and meeting with extensive shoals the force of the flood was checked, until it had attained some height, when it was hurried forward up the estuary of that river, and formed a dangerous "bore." Such could not be the case in the Mutla, from its deep water channel being at right angles to the course of the flood, and immediately connected with the deep water in the centre of the bay. On the other hand, with north-east winds, the deep water of the centre of the bay and the whole length of the gulf was forced seawards, and must be the cause of littoral counter currents running northwards, carrying with them the detritus to the head of the bay on both sides. Hence there was a preponderating power in the tidal currents, as well as the detritus brought down the rivers to find a resting-place there.

In regard to the amount of solid matter contained in the waters of the Hooghly, it was stated, that although Major Rennell had in his "Memoir of Hindostan" estimated the water of the Ganges to consist of one-fourth part mud, yet in other writings he had given it as only the $\frac{1}{200}$th part. This agreed more nearly with Mr. Piddingtou's experiments, which showed the quantity to be the $\frac{1}{615}$th part, and with the Rev. Mr. Everest's, who made it the 856th part, both during the rainy reason. The Nile contained $\frac{1}{120}$ of its bulk in mud, and the Humber $\frac{1}{180}$, of which latter, sand formed about 75 per cent. But even allowing that 78,000,000 cubic yards of solid earth were deposited yearly in the Hooghly and its estuary, this would only give an $1\frac{1}{2}$in. in depth over an area of 600 square miles, included within the 3-fathom contour; and if the area was extended to the 5-fathom contour, and embraced also the inlet of the Hooghly, then the area would contain 1,200 square miles, and the deposit would only amount to $\frac{3}{4}$in. in depth.

A belief existed that a great deal had been done by the former Government of India to facilitate a boat passage from Calcutta through the Sunderbunds. But by a return to Parliament, this amount appeared not to exceed £37,000; and the chief improvements in the canals in the immediate vicinity of Calcutta had been in throwing bridges across the streams, and in making roads on the banks. Scarcely any outlay had been incurred in straightening the water-courses, or in deepening them, either by manual labour, or by dredging. It was thought that one of the three Nuddea rivers, which were now only navigable during the months of July, August, and September, should have been rendered fit for navigation throughout the year, not only for the native boats, but for the light-draught steamers trading on the Ganges. According to a parliamentary return, the average cost per annum, extending over ten years, of maintaining these rivers, including salaries and the whole establishment, was £3,284; whilst the average tolls, after deducting the expense of collection, amounted to £14,486 per annum. There must therefore be a considerable balance in hand, which might well be laid out in straightening the best of these channels, deepening its bed and raising its banks, with other engineering works, so as to maintain a sufficient depth of water for the purposes of navigation.

Turning now to the Sunderbund district itself, it would be found that it comprised an area of 4,500 square miles of low lands inundated during the rainy season by the overflowing of the numerous rivers and water courses, producing a rank vegetation, and over most of it a dense jungle, the hot bed of fever, fatal to human life, and the miasma from which must, with certain winds, be carried to the cultivated districts, and even to Calcutta itself. If a proper system were adopted, of dividing this vast and at present useless territory, by a series of cuts, surrounding the districts by embankments, and allowing the water when charged with sediment to remain for a time within them, and run off at low tide, these lands would rapidly be warped up, probably two or three feet in a season, and make an ample return of most valuable produce, as had been for many years past so successfully adopted in the Trent, the Ouse, and other rivers in connection with the Humber.

It was belived that the flood and ebb tides both took the same course in the Mutla, whereas they entered and left by different channels in the Hooghly, and that this was sufficient to explain the difference in the depths of the channels. As to the utility of back water, it was argued that the Mutla navigation must have been maintained by back water through the same channel, and not by tidal scour alone; that it was made by the waters of the Ganges, and afterwards abandoned; and that so long as there was an absence of any great quantity of mud, the channels must remain open.

There were several other examples in India of harbours which were exceedingly good, where there was little or no fresh water, though originally made by the great waters from the land. The easterly and westerly branches of the Indus were at the present moment both tidal estuaries, and other places might be named.

It was mentioned that Barrow Harbour, on the north side of Morecambe Bay, afforded another illustration of an unchanging channel kept open by tidal scour alone; but, on the other hand, it was thought that the freedom from deposit in this harbour was due to the stream which ran through it. The harbour at Portsmouth, and, in a less degree, that at Ramsgate, were instances of harbours silting up for the want of fresh water scour, which, it was contended, should always be sought for to keep a harbour clear. To this it was replied, that there were numerous instances in which channels were kept open purely by tidal water, in fact such channels would always be maintained, if the water flowed through them with sufficient force to prevent deposit, whether the stream was continuously in one direction, or whether it oscillated backwards and forwards. In nature, every possible condition was of course to be found; in some cases the fresh water, and in others the tidal water greatly preponderating, and their relative quantities ever varying. For instance, the rivers flowing into the Baltic and into the Gulf of Mexico, possessed an enormous proportion of fresh and very little tidal water, yet the channels continued open. It was quite as erroneous to say, on the one hand, that fresh water was of no use, as, on the other, that a channel could not be kept open without fresh water.

When Great Britain was looking to India as the future cotton field of Europe, and when endeavours were being made to open that country to commercial enterprise, the importance of a well organised system of transit co-operation by railways, by water, and by ferry-bridges, could hardly be over-estimated. As

* Mr. Bailey held for many years the distinguished office of one of the Secretaries of this Institute. In that capacity he was most unwearied, courteous, and able, and much of the success of the earlier years of our history is connected with the exertions of Mr. Bailey and his distinguished colleague.

fifty millions sterling had been expended in trunk railways and canals, it would be necessary to improve and utilise to the utmost the river navigations, to act as feeders to those main lines; and to provide an additional number of river boats. Since any alteration in the channels of the rivers, and especially of the great Delta, would be costly, and the result very uncertain, it was contended that it would be preferable to construct vessels of suitable size and form for the navigation of shallow and tortuous rivers, and that economy of transit, as well as management of the vessels, was, in such cases, mainly dependent on the efficiency of the steering and towing apparatus.

It was observed, that no great faith could be placed in any scheme for the improvement of Indian rivers, inasmuch as for eight or nine months in the year the weather was perfectly dry, and for four months there was a tremendous rainfall, producing an immense flow of water, when the rivers assumed a character quite unprecedented in this country.

With respect to the change of the seat of trade from Calcutta to the Mutla, there were as many difficulties in the way as if the attempt were made to transfer the trade of the Thames at London to the Medway. It was more a question of economy than anything else; for if millions of money had been sunk in the erection of warehouses and buildings for the purposes of trade, that was an element quite as important as the question of the river itself. Looking to these facts, and to the delays and cost of unloading a cargo twenty or thirty miles from the place to which it was consigned, and conveying it that distance by railway, it was thought that there was no prospect of the navigation of the Hooghly being changed for that of the Mutla. To this it was replied that the difference of expense between Mutla and Calcutta would be considerably in favour of the former port. It was thought that preference should be given to a river where there was always 26ft. of water, to one which was beset with shoals; and to a river, the mouth of which was only 50 miles from the head of the navigation, available in one day's steam, to one which required three day's steam, in a country where steam-power was costly. It was not a question of superseding Calcutta as a port of commerce, but it was contended that Mutla would form a valuable auxiliary—like Birkenhead to Liverpool—and that by the route advocated the physical difficulties of the approach would be lessened, and the same point arrived at, only with diminished risk and greater economy.

In closing the discussion, it was remarked that there was not sufficient information relative to the physical features and the conformation of these rivers, to enable a proper discussion to be raised on matters specially appertaining to the Institution. With regard to the commercial part of the subject it should be said, that there was always great difficulty in changing the locality of an important commercial business. No doubt there were large establishments at Calcutta, with all the accessories for the transhipment of goods. Granting that the Mutla had all the advantages ascribed to it, a long and severe struggle would be made on behalf of existing interests, though it should not be treated as a hopeless affair, especially as it had been stated, and not denied, that the Mutla presented an unchanging channel, accessible at all times. As Southampton had been cited, it might be said that, although the heavy merchandise trade had not been drawn there, yet that port was resorted to by the trade requiring quick transit—mails and passengers. In like manner, probably, the first trade to frequent the Mutla would be the mail steamers, for which speed was the main object, and in the course of time it might receive a share of the heavy trade.

LONG TUBE BAROMETER.

After the meeting, Mr. R. Howson exhibited in the library a barometer, consisting of a long tube freely suspended open end downwards, a cistern, which was of a tubular shape, and a "stalk." The stalk was a glass tube, sealed at both ends, attached firmly at its lower end to the bottom of the cistern, and rising axially up the tube until it nearly reached the surface of the mercurial column. The consequence of this arrangement was, that the top of the stalk came into a region of very low pressure, and there was an excess of pressure tending to force the cistern upwards. This excess was represented by the weight of the cistern (and stalk), and the contained mercury, so that under a given atmospheric pressure, the cistern would always hang suspened at a given level. When the pressure of the atmosphere rose, a portion of mercury left the cistern and passed into the tube, and the cistern also rose, until the level was replaced by the immersion of the glass which formed the tube. When the pressure fell, the converse took place. An elongated scale was thus produced, the extent of range being dependent upon the relative areas of the tube, and of the glass which composed it. The action might also be simply viewed as that of a long piston, or plunger, with a liquid packing, having a vacuum on its upper side, and a self-graduating weight attached to its lower side.

November 26, 1861.

J. R. McCLEAN, Esq., VICE-PRESIDENT, in the Chair.

The Paper read was "On Measuring Distances by the Telescope," by Mr. W. B. Bray, M. Inst. C.E.

The author's attention was attracted to this subject by a Paper by Mr. Bowman, read before the British Association in 1841; but it required further investigation and modification to bring it into a form of practical utility.

He found that it was convenient to have two distance hairs on the diaphragm of the level, one about $\frac{1}{20}$ of an inch above the level hair, and the other as much below, so as to read 1ft. on the staff at 1 chain, and 10ft. at 10 chains. Since, however, in focussing the instrument to any object, it was necessary to bring the cross hairs into such new focus, which was proportionally further from the object glass as the object was nearer, the angle which the hairs subtended from the centre of the object glass must be variable, diminishing as the distance was diminished. Hence a correction was necessary, and this the theory of refraction by lenses furnished. It showed that the error was constant at all distances, amounting in every case to the focal length of the object glass for parallel rays. This constant was to be added in reading the staff, by bringing the lower cross hair near any even division of feet, but exactly ·02 of a foot above it, corresponding with the two links from the centre of the instrument to the anterior focus, in the case of a 5-inch theodolite and 10-inch level. Then, by reading the upper distance hair, and deducting the even number of feet at the lower hair, the difference was the distance in chains and links. If the compass was sufficiently delicate, any operation of contouring, or running trial levels, could be performed with rapidity and accuracy. When provided with the two distance hairs, the level of the ground could be taken above and below the ordinary range of the instrument. The use of these distance hairs for eighteen years had proved their practical value. In taking the widths of rivers, or deep ravines, distances of 20 chains had been read in favourable weather; and when the hairs were accurately fixed on the diaphragm, they might be used even for fractions of a link, in taking widths incapable of direct measurement.

When applied to a theodolite, they could be used for measuring distances on sloping ground. But in that case, since the line of sight was no longer perpendicular to the staff, a correction was necessary, for which a table was given. showing the angles of elevation of the various heights, which were simple fractional parts of the horizontal distance. When the horizontal distance to the staff had been ascertained, the theodolite was to be elevated to the tabular angle corresponding to the fractional rise nearest to the slope of the ground; then that fraction of the horizontal distance, less the reading on the staff, would be the correct rise. With the theodolite it was convenient to have another set of hairs, for reading the distance in feet, as well as in links. In clear weather, with a distance reading staff, a distance of 40 chains had been read between the foot and link hairs.

In the course of the discussion it was remarked, that the arrangement described by the author was of a much earlier date than had been mentioned. Possibly its application might hitherto have been limited, from the want of a correction for the errors introduced in focussing the instrument, which had now been supplied. Reference was made to the micrometer arrangement of the diaphragm in Mr. Gravatt's original dumpy level. This system of measuring distances had lately been applied to rifle practice, and for military purposes generally, it was thought that a micrometer telescope could be relied on for distances up to 12 or 15 miles. It has also been employed for determining the speed of vessels at sea, when the exact length of the vessel was known, as well as for other purposes.

It was observed that the great improver of instruments of this kind was M. Porro, an officer of engineers in the service of Piedmont, a detailed account of whose "Instruments pour les léves de plans," was given by M. H. de Sernamont, in the *Annales des Mines*, 4th series, vol. xvi. (1849). None of the modifications in M. Porro's instruments had been introduced into this country, and yet with his micrometer scale of wires, the staff could be read off in metres at once—and, it was stated, at a distance of 800 metres the error did not exceed 2 centimetres.

December 3, 1861.

GEORGE P. BIDDER, Esq., President, in the Chair.

The Paper read was "On the Discharge from Under-drainage, and its effect on the Arterial Channels and Outfalls of the Country," by Mr. J. Bailey Denton, M. Inst. C.E.

This Paper contained deductions from a series of experiments made at Hinxworth, to ascertain the relative fall of rain on the surface, and the discharge of water from the under-drains. The experiments extended from 1st October, 1856, to 31st May, 1857. They were made on fields containing about 100 acres, in equal proportions of the two descriptions of soil into which the agricultural land of Great Britain requiring draining might be divided; viz: The surcharged free or porous soils, and the absorbent retentive soils, usually, though incorrectly, called "impervious clays." A description was then given of the lands experimented upon, as well as analyses of the soils. Also tables, which had been published in the "Journal of the Royal Agricultural Society," vol. xx. (1860), showing the daily rainfall, the discharge of water from the drains, the height of the barometer and thermometer, and the temperature of the soil at 18in. and 42in. respectively, below the surface.

The whole estate was drained by one connected system of works; but the mode of draining necessarily differed. Thus, the "free soils" were drained by occasional and wide drains from 4 to 8ft. deep, at a cost varying from £1 10*s.* to £3 10*s.* per acre; while the "gault clay" was drained uniformly, by a parallel arrangement of drains 25 and 27ft. apart, and 4ft. deep, at a cost varying from £5 10*s.* to £6 10*s.* per acre. In the latter case, the number of drains was increased to a maximum, the object being not only to remove excess of wetness, but to promote the aëration and disintegration of the soil.

It was remarked, that the average annual rainfall in the district was 24in., which had not been exceeded in the three years preceeding the experiments. The greatest fall in twenty-fours, during the eight months from October to May, was 0.542 of an inch, and the total fall was 10·045 inches, while the average fall, over the same period, amounted to 13in.

After some general remarks as to the time when under-drains commenced discharging, and upon the condition of the free soils and of the clays at Hinxworth, prior to under-draining, the Author proceeded to consider the effect of that operation. On the "free soils," and in fact on most of the mixed soils, it was observed that no water could run from the under-drains, until the water had been raised, by descending rains, to the level of the drains—which was not exactly the case with "clay soils"—and that as the surface springs rose higher and higher before draining, so the lowest drains would begin to run first, and as soon as the water bed of the whole are drained, forming an inclined plane, had risen by degrees to the height of every drain, the whole system would be at work, and not till then. The quantity discharged by the drains did not represent the whole of the infiltrated water, which included the water discharged by the drains; the water which gravitated to the out crop springs; and the moisture which rose from the subsoil beneath the drains by attraction into the soil above them, to be dispersed by evaporation at the surface. The quantity of water discharged by the surcharged "free soils" was rather more than two-thirds of the rain which fell on the surface, the actual quantities being 163,550 and 227,220 gallons per acre, or 7 and 10in. respectively. This proportion had reference to the rainfall of eight months only. If the discharge of the whole year were compared with the rainfall, it would be found to be less than one-third, arising from the fact, that while the discharge of the remaining four months was very trifling, the rainfall was 11in., or 250,000 gallons per acre. If the mean discharge for twelve months of the free and mixed soils were taken together, it would be found to amount to one-fourth of the corresponding rainfall, a proportion which would give 6in. in depth, or 135,732 gallons per acre as the mean quantity of water discharged from such soils to the outfalls from under-draining, a result not inconsistent with the experiments of Dickinson, Dalton, and Charnock. This quantity was, for the most part, new water rescued from evaporation, and would, *pro tanto*, swell the ordinary flow of rivers.

It was stated that, under ordinary meteorological and physical conditions, the under-drains of the free soils would begin to discharge in the month of October, or the beginning of November, and those of the clay soils in the end of November, or the beginning of December. Thus, at Hinxworth, the drains from the clay soils did not commence to discharge at all till the end of November, by which time 3¾in. of rain had fallen, or just sufficient to fill the inner pores of the soil, though the water had not risen to the height of the drains. After ceasing for a time, they commenced a continuous discharge early in January, when the water in the soil had risen to the height of the drains. The tables showed that as the character of the subsoil became more open and mixed, sudden discharge was lessened. It was when, by repeated rains, the clays had had their peculiar property of retention fully satisfied, and held within them as much in their drained condition as they were capable of holding, that they were in that state which fitted them to discharge the largest proportion of any subsequent rainfall in the shortest time. The total quantity of water discharged by clays annually, was small compared with that discharged by free soils. The Hinxworth experiments showed it to be only 59,931 gallons, or about 2½in., per acre. If this quantity were regular over the discharging period, it would not materially affect the arterial system of the country. But as a large portion of the heavier rainfalls was immediately discharged when the soil was saturated to the extent of its capability, and when the free soils would be discharging at least 1000 gallons per acre per diem, and the rivers might be pre-occupied by their present natural supply, and by the waters that passed off the surface without entering it, another feature of importance presented itself.

The general results of under-drainage, on the arterial water supply and outfalls, seemed to the author to be—first, to render the surface more capable of absorbing the rain that fell upon it; secondly, to lower the discharge of the upper surface springs in a slight degree; and, thirdly, to withdraw from the power of evaporation all the water which the under-drains discharged.

Upon the first result there could be no difference of opinion. If drained land were deeply cultivated, there would scarcely be any overflow from the land surface. But there were circumstances which must interfere with the complete absorption of which a drained soil was susceptible, and would prevent any very sensible reduction of the floods. Freshets, from such circumstances, would still prevail; though, as steam cultivation and deeper ploughing gained ground, a greater proportion of the rain would be admitted, and to a certain extent floods would be diminished.

With regard to the second result the deduction appeared equally clear. It had been shown by Mr. Charnock, in his Holmfirth experiments, which extended from 1842 to 1846 inclusive, that evaporation from an undrained soil, maintained in a state of saturation, was 8in. more than the rainfall, while that from the same soil, when drained, was 5in. less. The effect of under-draining upon the main perennial springs which supplied the rivers, was, therefore, to increase and not to diminish their flow, as had been stated; a circumstance considered of great advantage when viewed in relation to the increasing pollution of the rivers by the discharge of town sewage. Again, the beneficial effect upon vegetation of lowering the standard water-bed during the spring and early summer, when all vegetable life was in its most sensitive stage, could not be overrated. The Hinxworth experiments showed that, in March, April, and May, the temperature of the drained soil was higher by 2° Fahrenheit than the undrained soil. As a further illustration of the evil of a shallow water-bed, it was mentioned that, during the survey for the drainage of the Test Valley, in 1852, a violent storm occurred, which blew down many trees. It was then found that the relative height of the several tree bottoms formed one line, or inclined plane, precisely agreeing with the water level throughout the length of the valley, and showing that the soil of that valley, and of those of which it was a type, was maintained in a state of wetness very closely approaching complete saturation.

As regarded the third result, that under-drainage diminished evaporation and so lessened the rainfall, it was observed, that as Great Britain was surrounded by the ocean, a sufficient supply of water would be obtained from that source. Dr. Dalton had stated that in England the average quantity evaporated from a water surface was 44·43in., while Mr. Charnock showed it to be 35in. at Holmfirth; both in excess of the rainfall, with the quantity of moisture precipitated as "dew" added.

In conclusion, the hope was expressed, that sufficient had been advanced to show that the tendency of under-drainage, as at present progressing, was to augment the ordinary flow of rivers at that period of the year when the soil was saturated to the extent of its capability, and that the time was not far distant when the subject of this paper would force itself upon the attention of the country.

With regard to the Act of last Session, which enabled the proprietors of the lower lands to remove mills, dams, weirs, and other impediments, under certain conditions, it was explained that these legal facilities, though they would aid in the removal of certain irremediable obstructions, did not involve any actual reduction of mill power in the aggregate. On the contrary, it was believed that, in a majority of cases, the point aimed at would be not the destruction of the mill, but the means of discharge into the mill-tail, and that many valleys would be divided into a series of smaller areas, feeding each other with increased water supply, by the actual process of draining.

December 10, 1861.

George P. Bidder, Esq., President, in the Chair.

Before proceeding with the regular business, the President directed attention to the numerous donations to the library, which had been received during the recess; particularly noticing the series of "Transactions of the North of England Institute of Mining Engineers" (7 volumes) through the President of that Institute, Mr. N. Wood, M. Inst. C.E.; the volumes containing the abstracts of "The Principal Lines of Levelling in England and Wales" and in Ireland, from Colonel Sir Henry James, R.E., C.B. (Assoc. Inst. C.E.); "The Quarterly Review," vols. I. to LX., from Mr. J. S. Crossley, M. Inst. C.E. Thirty-five volumes of "Greenwich Observations" and other publications of the Royal Observatory, Greenwich, through Professor Airey, Hon. M. Inst. C.E.; the "Annales des Ponts et Chausées" from 1843 onwards, through Monsieur Cavalier, Directeur de l'Ecole des Ponts et Chaussées; "Journal of the Franklin Institute" from 1851 to the present time, from the Institute; a set of the Alphabetical, Chronological and Subject-matter Indexes of Patents for Inventions, together with the Abridgements of Specifications relating to different subjects, from H. M. Commissioners of Patents, through Mr. Bennet Woodcroft; the series of volumes detailing the Magnetical and Metereological Observations made at different stations in the British Colonies, through General Sabine, President of the Royal Society: the Publications of the Geological Survey of Great Britain, through Sir Roderick Murchison, Director General; A Geological Chart of the Austrian Empire ("Geognostische Uibersichts Karte der Oesterreichischen Monarchie") from Mr. J. R. McClean, Vice President; and a copy of the New Edition of "The Encyclopædia Britannica," from Mr. H. P. Stephenson, Assoc. Inst. C.E.

The President, in proposing that the cordial thanks of the meeting be given to the several donors, expressed the hope that these excellent examples would not be lost upon the many new Members and Associates who had recently joined the Institution, and that it would be the constant aim of the members of all classes to maintain the library in the highest state of completeness.

CORRESPONDENCE.

We do not hold ourselves responsible for the opinions of our Correspondents.

HEAT AND STEAM.

(*To the Editor of the* Artizan.)

Sir,—The economical production of power from the application of heat in our prime movers is becoming every day a question of increasing importance; and as the theory of our heat engines is generally allowed to be still comparatively obscure, every well-directed attempt to throw light on the subject cannot fail to excite interest. Professor Rankine's work on the steam engine and other prime movers shows the importance of applying mathematical reasoning to the abstruse subject of thermo-dynamical principles, and perhaps not the least interesting feature of the book is the application to our thermic engines of Joule's theory of the equivalence of heat—a theory which has been developed by the first physicists and mathematicians of England and the Continent, and which is now so generally received by theorists, that no small amount of moral courage is required to attempt to raise a doubt of its general correctness. Yet, after the unremitting labour of many years devoted to the object of combining theory with practice in the construction and working of steam engines, I have been reluctantly forced to conclude that the modern thermo-dynamical theory—beautiful as it undoubtedly is, and fortified, as it has been, by apparently impregnable mathematical defence—is not satisfactory; and in a little work recently published, on the thermo-dynamics of elastic fluids, I ventured to put forward my reasons for dissent, and to suggest some ideas of my own on the subject.

Much interest has been lately excited by Mr. W. Williams's treatise on heat and steam; a work which differs essentially from Professor Rankine's in treating the subject in what is intended to be a purely practical manner, apart from mathematical reasonings, and illustrated by numerous apparently simple and convincing experiments. After having attentively studied the work and carefully repeated some of the experiments, I must be allowed to state my impression that the conclusions arrived at by the author are not convincing; and as many other readers may be desirous of seeing the subject further elucidated, I hope that Mr. Williams will receive in good part the remarks which I shall take the liberty to make on his theory, coming, as they do, from a fellow labourer in this most interesting field of inquiry, whose object is equally to elicit truth, and whose ambition is (like Mr. Williams's own), to contribute a mite towards the improvement of our thermo-dynamical engineering.

The liquid *water* is described as being a combination of the solid *ice* with heat, and Mr. Williams imagines the change from the liquid to the vaporous state to be a consequence of each water atom receiving a further unit of heat beyond that which it is capable of retaining in the latent state. Now, as the heat which (in the common language of physics), water receives from 32° to 212° is sensible, or affects the thermometer at every stage of the heating process, it follows that liquid water does not receive or retain heat in a latent state, and consequently that vapour must be formed from the first moment that heat is conveyed to the liquid, and retained in it in quantity corresponding to the thermic phenomena of temperature. This is the prominent feature of the "new views" developed in the treatise, which appear to be based on the following assumptions, viz.:—

1st.—That water is a non-conductor of heat, and, therefore, cannot be a receiver of heat; and

2nd.—That because water is (practically speaking) incompressible by mechanical force, it must be inexpansible by heat.

The ingenious experiment by Mr. Murray of heating water from the top in a cylinder of ice, proved that water does conduct heat, though slowly. Air is allowed by Mr. Williams to be a recipient and conductor of heat, "capable of receiving and imparting heat to other matter, from atom to atom." Yet it will not easily conduct heat downwards, and we perceive that, as in the case of water, the hottest particles, being the lightest, float on the top of the mass, thus showing that the freedom of motion in the particles of liquids and elastic fluids which allows them to assume the positions due to their comparitive density, has some influence on the phenomena, though we must allow that this does not explain why the heat should not be communicated downwards from atom to atom of the fluid itself. But this difficulty of transmitting heat by conduction in fluids does not prove that liquid atoms cannot receive heat without at once becoming vapour. In some manufacturing processes involving extensive evaporization of liquids, the heat is applied from above, thus causing vaporization and evaporation apparently at the same time; but we have no proof that (under atmospheric pressure) the surface particles do not individually acquire the temperature of 212° by a comparatively gradual process of heating before suddenly taking the large extra dose of heat required to change them into the vaporous state. Mr. Williams's views on this point seem to be influenced by his ideas of the atomic constitution of heat, which are not definitely expressed, and require further elucidation. How are we, according to his theory, to conceive of the heating of a mass of ice from the absolute zero of temperature (if such exist) to the point of liquefaction, or 32°? If the particles of water in the solid state can combine with heat only in atomic proportions equivalent to the change of state of each particle, we must imagine that the thermometric indications of heat in ice are the result of liquid (or vaporous) particles diffused throughout the mass. If a mass of ice be placed in a vessel full of saturated steam communicating with an unlimited supply of steam at a constant pressure, the solid particles of ice on the surface, uniting each with the "dose of heat" equivalent to its liquefaction (or 140 degrees, in the common language of physics), would assume the liquid form at, say 32°; this dose of heat must come from the steam, and as each particle of the steam is supposed to consist of an ice-cold liquid particle, combined with a dose of heat represented by 1000°, it would be requisite to imagine that several ice-atoms, in becoming water, must in common receive the heat from one vapour atom—suppose 7 ice-atoms, absorbing together the heat of 1 vapour-atom, as $7 \times 140° = 980°$; and by the new theory we should have one cold atom of water from liquified steam, and 7 equally cold water-atoms from the liquified ice, as representing the immediate result of the operation. But the supply of heat in the steam being unlimited, we perceive that the whole contents of the receiver would very soon indicate a temperature of 212°—how account for this state of things? By the common theory we should say briefly, but vaguely, that the cold water would condense about $\frac{2}{11}$ of its weight of steam, and the whole would then show the temperature of 212°. Following up Mr. Williams's theory, we should say that $5\frac{1}{2}$ of the 8 atoms of water would exert their combined influence on 1 atom of steam, and coerce it into the space which they themselves continue to occupy, + $\frac{1}{25}$ expansion, the combined group producing the effect of 212° on the thermometer. Or, as we cannot deal with half atoms, say that, in a larger mass, 11 water atoms may combine their coercive forces in drawing down 2 steam atoms, and holding them captive. The difficulty of dealing with an atomic theory applicable to supposed imponderable agents is sufficiently obvious, and is not perhaps likely to lead to much edification in the present state of our knowledge on these intricate subjects; but the inquiry is legitimate, and ought to be encouraged.

If, with Mr. Williams, we allow that hot water is a mixture of ice-cold water atoms with a certain proportion of vapour atoms equivalent to the temperature of the mixed mass, we must imagine the liquid atoms to exert a marvellous force of coercion and repression on the vapour atoms which come within the sphere of their influence, until the liquid mass acquires its saturating equivalent of vapour, corresponding to the boiling point, under the given circumstances; and it is certainly difficult to reconcile the idea of this repressive force with the Daltonian theory so much insisted on by Mr. Williams, viz., that a liquid may be considered to act as a vacuum to the diffusive property of elastic fluids. It may not be superfluous to explain here that, though a gas or a liquid may, according to Dalton, be considered to act as a vacuum to the diffusive property of æriform or vaporous fluids, it is only in this respect that we can so consider it, for otherwise its presence is sufficiently evident in the increase of pressure resulting from the mixture of the fluids in a given space. It is not difficult to imagine that vapour may be formed and diffused in water at any temperature, as, notwithstanding the general incompressibility of liquids, we perceive from many physical considerations that vacant spaces must exist between their molecules, as for instance the dissolving of anhydrous salts in water without increasing its volume. We cannot suppose, however, that a large proportion of gas or vapour may be thus retained in water; the most that is contended for, according to Dalton's views, seems to be a volume of vapour equal to the volume of the water, supposing the density of the vapour to be the same as it would assume in a vacuous space at the given temperature. Thus at 212° we should suppose 1 cubic inch of water under atmospheric pressure to contain 1 cubic inch of steam of atmospheric pressure + the increase of volume due to the observed expansion of the liquid from 32° to 212°, or about $\frac{1}{25}$, making the total quantity of steam contained in the water equal to 1·04 cubic inch. But it is repeatedly mentioned in the treatise that a mass of water freely exposed to the air will lose about $\frac{1}{8}$ of its weight by evaporation in cooling from 212° to common atmospheric temperature, say 60°, which is nearly correct; and if we suppose that the heat of the liquid, as indicated by the thermometer, is due entirely to vapour existing in it, we must allow that in the space occupied by 1·04 cubic inch of water at 212°, there exist $\frac{1{\cdot}04 \times 1700}{8} = 221$ cubic inches of atmospheric pressure steam, which, *if occupying the same extent of vacuous space*, would exert an elastic pressure corresponding to upwards of 200 atmospheres!

It is generally believed that gases may be actually dissolved in liquids, as we suppose air and carbonic acid gas to be held in solution in spring water, thus allowing that the liquid molecules may possess an immense repressive force over the expansive tendency of the gaseous atoms, equal to about 37 atmospheres for carbonic acid, and beyond what has been practically obtained from any possible amount of actual mechanical pressure on dry air. It is true that the known amount of this property of liquids is generally within the limits which Mr. Williams's hypothesis would require, but even as far as it extends, the analogy does not apply to the case in point, as dissolved or liquified aqueous vapour can be nothing but water. However, Mr. Williams, though not strictly consistent on this point, assumes generally that vapour exists in hot water in the state of an elastic fluid, and we should expect that a mixed mass so constituted would possess a considerable degree of elasticity or compressibility. Is Mr. Williams prepared to say that water at 210° is much more compressible than water at 33°?

The only causes assigned for the supposed coercive power of liquid over vapour atoms are the pressure and density of the liquid. The atmospheric pressure is equally exerted on the steam existing in the steam space of an open boiler, and on that said to be contained in the subjacent liquid, and the additional pressure of the liquid itself in a shallow mass would be but trifling. And it is difficult to perceive how density alone can exercise such an immense repressive force on the expansive elasticity of vapour; indeed, as far as density alone is concerned in the phenomena, mercury should have a "saturating equivalent" greatly exceeding that of water, whereas we know that its specific heat is only $\frac{1}{30}$ of that of water, and, consequently, by Mr. Williams's theory, it would contain but a small quantity of its own vapour diffused throughout its mass as compared with water at a temperature comparatively equal for the respective range of each liquid between its freezing and boiling points.

It seems difficult to explain by Mr. Williams's theory why, at temperatures below the boiling point, some of the vapour atoms escape into the air, while the unsaturated liquid still possesses an active force which might effectually hold them down; in fact, the thinnest stratum of oil on the surface of the water at *c*, Fig. 4, in the experiment described at page 14 of Mr. Williams' treatise, would prevent vapour from rising into the upper part of the tundish *a*, at temperatures which do not produce some degree of actual ebullition. Moreover, if the experiment be made with water perfectly free from air, and the inverted funnel be absolutely full of the liquid, thus completely excluding all contact of air, it will be found that no water will be displaced by vapour rising through it, from the bottom strata of water in the containing vessel, unless the heat applied from beneath be sufficient to cause some degree of ebullition. In each experiment the pressure of the atmosphere remains unaltered on the water contained in the inverted funnel, and the density of the liquid remains the same as when it was in free contact with air; why, then, does the water acquire an increase of temperatuer without any escape of vapour; or, by Mr. Williams's theory, why does the vapour accumulate in the liquid under these circumstances? The ready, though not very explanatory answer is—because it has no surface in contact with the gaseous fluid which produces pressure on it and prevents ebullition. There can be no doubt, however, about the correctness of Dalton's well-known law for mixtures of vapours and gases, viz., that the quantity of vapour which occupies a given space is the same at equal temperatures, whether the space contain a gas or is vacuous; and also that the pressure of the gas on the liquid, though it retards, does not prevent evaporation, provided that the liquid surface be in actual contact with the gas. From a superficial perusal of Mr. Williams's experiment at page 15, Fig. 6, we might be led to imagine that the vapour rising quickly from a thin stratum of water at the bottom of a tall cylindrical vessel, on the application of a gentle heat from beneath, almost instantaneously *fills the vessel*, as shown by its condensation on a cold surface over the mouth of the vessel, without reflecting that a large portion of the air keeps its place in the vessel, and becomes saturated with the vapour which is equally diffused throughout its mass, and thus dew is immediately formed on any cold body which is brought into contact with the moist warm air.

It may not be out of place to suggest here that such experiments as Mr. Williams describes should generally be made with a bath for communicating the heat to the bottom of the vessel containing the liquid under operation, as from long experience in similar researches I have reason to think that the direct effect of flame on the containing vessel produces results often unequal and irregular, sometimes apparently anomalous, which it were better to avoid.

A singular result of the new theory, as pointed out in the section on condensation, is that in the condenser of a steam engine the injection water does not become hotter by contact with the steam, nor does the steam become colder from contact with the water, the result of the operation being a contraction of the steam into a very small volume, which, mixing equally throughout the liquid, gives the result of temperature in the mixture. This is a necessary consequence of the assumption that heat cannot be imparted to a liquid. "In a word, heat cannot be received and *retained* by *liquid particles*, each of which is susceptible of an instantaneous change it its own statical or electrical condition, by the accession of heat. As well might we expect that atoms of ice could receive and absorb heat, and have their temperature raised, yet *still retain their crystalline* *form and status of ice*, as that those of water could receive it and retain their *status of liquidity*." Here we have a clear statement of the author's ideas of the application of the atomic theory to an imponderable fluid of heat, which, however, would, I think, lead farther than he intended. Thus, as already stated, we should have to imagine that heat in ice must be the result of liquid particles diffused throughout its mass; and, further, as saturated steam cannot receive any additional increment of heat without becoming *superheated*, and thus assuming for the time the perfect gaseous state, we should be led to conclude that since heat can be communicated only in atomic proportions, the effect of superheating must be produced by a diffusion of some particles of perfect steam-gas throughout the mass of vapour, as we consider hot water to be a mixture of cold liquid atoms with vapour; and, moreover, if water may be truly called a second state of the substance *ice*, steam-gas may be fairly considered as its *fourth state*. Mr. W. is no doubt right in asserting that in an atom of common steam there is no such thing as a high or low temperature, these terms solely applying to difference in the number of vapour atoms occupying any given space (p. 138); but this description will not apply to steam-gas, as vapour in this state assumes various temperatures simply by heating or cooling, the mass and volume remaining constant. These characteristics of vapours have not been sufficiently noticed by physicists.

I shall now offer a few remarks on Mr. Williams's assumption that because water is (practically speaking) incompressible by mechanical force, it must be inexpansible by heat. It is difficult to assign a satisfactory physical cause for the expansion of water by cold from its temperature of greatest density, or about 40°, down to the freezing point, unless we allow that it arises from some peculiar arrangement of the liquid molecules; and the still greater expansion of the mass in the act of becoming solid ice, seems obviously due to the peculiar mechanical change of position or arrangement, assumed by the particles in the change of state. Our highest authorities in physical science seem now to be agreed that common thermometric heat is only a condition of the material substances in which we observe it. Yet it is not improbable that the physical cause of the phenomena of heat in ordinary matter may be of an etherial origin so subtle as for ever to baffle human powers of research. Mr. W. seems to adhere to the hypothesis of a specific fluid of heat as taught by Black and Lavoisier. According to Dr. Black, a particle of water attracts and unites with one or more atoms of heat "in changing from the solid to the liquid state; and, conversely on the congelation of the liquid, these atoms of heat are set at liberty by fixed laws." Still, unless we allow that really opposite causes may produce identical effects, we must concede that since the mechanical arrangement or condition of the particles of water in cooling below 40°, produce expansion of the mass, expansion *may* also be caused by a peculiar arrangement or condition of the liquid particles, which we call heat, or the effect of heat in the liquid mass.

Mr. Williams's theory of boiler explosions may be tested by one decisive experiment. Taking care that the water be perfectly free from air, and that the steam space in the bottle (Fig. 43, p. 170) contain nothing but common saturated steam, say 218° temperature and corresponding pressure, the stop cock being shut, let the water be well shaken up, and it will be found that *no perceptible rise of temperature takes place*. To make the result more convincing, let the bottle be well wrapped up in flannel to prevent loss of heat. Now, as in water and in saturated steam the temperature and pressure must correspond, it results that *no increase of pressure takes place* in the *operation*. If the steam space contain air, *or superheated steam*, an increase of pressure, perhaps an explosion might be expected from the frothing up of hot water among the partially gaseous atmosphere. It would be occupying too much of your valuable space to enter upon the *rationale* of boiler explosions, and I may be pardoned the egotism of again referring to my recent essay on the thermo-dynamics of elastic fluids for some hints on a theory of these fearful phenomena, which will, I think, be found in accordance with well proved physical laws, and I venture to hope it may lead to real practical good by throwing useful light on a subject generally acknowledged to be still very obscure.

Mr. Williams's book will, no doubt, do much good by stimulating inquiry and original research, though scientific readers generally are not likely to be convinced by his arguments, as they do not stand the Procrustean test so freely applied by him to the common theories of heat and steam, by measuring them by an arbitrary standard, and, moreover, the correctness of the standard which he proposes is by no means satisfactorily proved; and I imagine that it must be a matter of disappointment to his numerous professional readers to find that a work written by a professedly practical man, illustrated with numerous plain practical experiments, and decidedly aiming at practical results, should prove to be almost wholly impractical. Respecting both the generation and condensation of steam, it leaves us where we were, as to practice; for we do not perceive anything suggestive of improvements in steam boilers, and as to the process of condensation we do not perceive any essential difference in result between the actual removal of the heat from the vapour by cold metallic surfaces, and its remaining in the mixture of injection water and vapour so affected by the cold as to render it incapable of expanding the steam beyond the bulk of so much water at the given temperature, which is the very object in view; and if this shrinking in of the steam is the instantaneous result of a well-arranged injection of cold water—as is actually the case—the common mode of condensation would, *on this point alone*, leave little to desire. The collateral advantages of surface condensation as to supplying the boilers with distilled water, &c., great as they are, have nothing to do directly with the theory of condensation.

The preceding remarks were written several months ago, and I have since seen the second edition of Mr. Williams' book, which contains an additional section "on the subject of the Jet when brought in aid of the natural draught in the furnaces of land and marine boilers. Here the author is evidently at home, and I imagine that the union of sound theory with efficient practice, which distinguishes this section, must meet with general and unqualified approbation.

Palermo, December 10, 1861. JOSEPH GILL.

NOTICES TO CORRESPONDENTS.

R. (Dumfries.)—Your plans have been received. You will be communicated with by post.

A. C.—The book to which you refer, was written by Capt. A. Ledieu, and may be had of M. Dunod, Quai des Augustins, 49, Paris. We believe it is published at 30 francs.

Resident Engineer.—We strongly recommend Saxby's patent apparatus for working railway signals and points. It is the only apparatus which effectually prevents contradiction between the signals and points.

X.—Messrs. Smith and Houghton, of Silver-street Wire Works, Warrington, are makers of the best music wire. The tensile strength of some of their fine music wires proved to be equal to about 120 tons per square inch. We cannot answer your other question.

W. J.—We will forward you a correct sketch of the plan.

L. G. (Britton Ferry).—Shall we send you a list of useful books which will be quite available for your purpose?

M.C.—The apparatus of Mr. J. F. Datichy was, we believe, made by Messrs. Imray and Copland, Westminster Bridge-road.

F.R.S., Capt. R.N., Angula, and B.—Mr. Geo. Rennie described fixed and floating batteries, with iron outer casing,—and some built entirely of iron (with angular or sloping sides), if we remember rightly, about ten or eleven years ago; and his models were deposited either in the United Service Museum, Whitehall, or at Kensington.

Alpha.—The new fast steamers running between Southampton and the Isle of Wight, were designed by Mr. Ash, of the Thames Iron Works, Blackwall.

B. (Bath).—The same plan was designed by Mr. Fryer nearly two years ago.

Express.—Mr. Charles Wye Williams has, we believe, successfully treated the four Holyhead Mail Packets, and the constant emission of dense smoke has been got rid of. They are now working much more economically than before. This is mainly due to a slight increase of time allowed for each passage.

Numerous other correspondents have been answered by post; but we must beg of such of our correspondents who have not supplied us with their addresses, to do so, to enable us to answer their enquiries.

NOTICE.

We take this opportunity of reminding our subscribeas that the amounts for subscriptions, payable in advance, for 1862, are now due and payable, and should be remitted forthwith, to entitle subscribers to receive the Presentation Plate.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Kernot *v.* Potter.—Potter *v.* Kernot.—This was an action tried in the Rolls Court, from which it appears that the first of these two suits was instituted to enforce an agreement for the working of the plaintiff's patent for the manufacture of refined paraffin, and for an account of profits earned by the defendant. The object of the second suit was to cancel the agreement. His honour, in giving judgment, said the terms of the agreement, dated January, 1859, were that the plaintiff should take out a patent for purifying crude paraffin, and should assign the patent to the defendant, who undertook to work it for fourteen years, if it could be worked so long for profit, and to pay to the plaintiff a stipulated portion of the profits which he should earn by the manufacture. In April, 1860, the defendant gave notice to the plaintiff that the agreement was at an end, inasmuch as no profits could be realised by working the process. Having carefully perused the evidence, the Court was of opinion that the manufacture could not be carried on except at a loss of one penny on each pound of paraffin refined. That being so, it was clear that the Court could not decree specific performance of the agreement, nor grant to the plaintiff the relief which he asked. Nor, on the other hand, could the Court in the second suit declare that the agreement was invalid *ab initio*. The Court thought that originally the agreement was good, but that it came to an end as soon as in the *bonâ fide* working of the process no profits could be realised. Neither of the parties had any remedy in equity, and, therefore, both bills must be dismissed.

Watkins *v.* Reddin.—This was an action brought in the Court of Common Pleas on the 5th ult., by which the plaintiff sought to recover compensation for injuries sustained by him, alleged to have been occasioned by a certain engine, which was the property of the defendant. Plea, not guilty. It appeared from the evidence of the plaintiff, that on the 19th of July last he was a passenger by an omnibus running from Hampstead to the City. When they were in the Hampstead-road they heard a hissing and rumbling noise, and a short time afterwards perceived one of "Bray's traction engines" coming up the road towards them. Upon meeting the engine the noise increased, and the horses became frightened; the near side one pulled very much, ran up over a bank by the side of the road, and capsized the omnibus. The plaintiff was thrown with great violence from the roof, and his arm was dislocated. He was confined to his house for a fortnight, and was unable to use his arm up to the present time. Evidence was then called to show that these engines were very dangerous things, and calculated to frighten horses. The defence was, that the accident was not occasioned by the engine frightening the horses; and to prove that horses were not in the habit of taking fright from the effects of the hissing of the engine, witnesses were called, who stated that the engine had been driven through the most crowded thoroughfares in London, and also to the Derby when the roads were full of horses and vehicles, and this was the only instance of horses taking fright. The jury returned a verdict for the plaintiff, damages £87, being of opinion that the defendant was aware that his engine was in the habit of frightening horses.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

THE THAMES EMBANKMENT.—Mr. Cowper, the First Commissioner of Works, has addressed a letter to the Lord Mayor, informing him that the government have resolved upon reappointing the Royal Commission, which sat during the past summer to consider the question of banking the Thames, and which presented a report to the Crown, recommending the embankment of the north, or Middlesex side only, for the present at least. It will be the duty of the Commission, so re-embodied, to deliberate again on the practibility and the desirability of carrying an embankment along the southern side simultaneously with that on the northern side. The project, as respects the Surrey side, it will be remembered, the commissioners recommended to defer for the present, so that they are now in the position of a jury invited to reconsider their verdict.

THE POSTAL SERVICE BETWEEN ENGLAND AND AMERICA.—The following is the text of the 20th article of the last postal convention between Great Britain and the United States, viz.:—"In case of war between the two nations, the mail packets of the two offices shall continue their navigation without impediment or molestation until six weeks after a notification shall have been made on the part of either of the two governments, and delivered to the other, that the service is to be discontinued, in which case they shall be permitted to return freely, and under special protection, to their respective ports." Most of the American mail packets subsidised by the United States' government, sail under the Bremen and Hamburg flags.

PASSENGER TRAFFIC BETWEEN FRANCE AND ENGLAND.—The usual yearly statistics of the passenger traffic between France and England have been published by the French Custom-house. It appears that the number of passengers arrived at or leaving the French ports, taking arrivals and departures together, were as follows in 1860: Boulogne, 102,829 passengers; Calais, 74,875; other ports, 55,833; total, 233,537. In 1859 the numbers were: At Boulogne, 86,579 passengers; Calais, 67,311; other ports, 51,566; total, 205,457. There is thus an increase at Boulogne of 16,250 passengers; at Calais, of 7,564 passengers; at the other ports of 4267 passengers. The total number of passengers between British and Belgian ports amounted to 27,722 in 1860.

THE SURVEY of a parallel of north latitude, running through Ireland, England, Belgium, Prussia, and Russia, is nearly completed, and the accurate length of a base line stretching from the west coast of Ireland to the Ural mountains will very shortly be ascertained. This will be the greatest feat in trigonometrical surveying ever accomplished. In order to triangulate the country along the parallel, stages 70ft. high have been erected on the continent by the Royal Engineers. The triangulations for the purpose of ascertaining the length of the base line will be calculated at the Ordnance Survey Office in Southampton.

THE GREAT MONT CENIS WORKS.—A letter recently received from M. Sommeiller, who is directing in chief the great works connected with the perforation of Mount Cenis, states that everything is proceeding satisfactorily. Hitherto the boring has been carried on only at the south end; but, in a short time, machines will be set to work on the north side also. Progress is now being made at the rate of about 7ft. a day, and this speed will be doubled by February; but it will take at least six years more to accomplish this extraordinary and almost superhuman task.

TESTING IRON.—By direction of the Admiralty, a number of samples of various descriptions of iron, from Earl Dudley's iron-works, Staffordshire, have been submitted to powerful tests at Chatham Dockyards, with the view of ascertaining whether they were of a kind suitable to be used in the construction of the *Achilles*, 50. The trials, which extended over the 15th ult. and the previous day, took place in the testing-house at the dockyard, and were attended with the most satisfactory results, nearly seventy samples being tested, and all, with only one or two exceptions, bearing a strain of several tons to the square inch beyond that required by the Admiralty standard. In one or two instances the hydraulic testing machine, with a pressure of upwards of 60 tons to the square inch, failed to fracture the portions of iron under trial, although the standard required by the Admiralty is set at 22 tons to the square inch with the grain, and 19 tons against it.

NEW RIVET-MAKING MACHINE.—A new description of rivet-making machine, for manufacturing rivets for the iron frigate *Achilles*, has arrived at Chatham from Manchester. The saving of manuel labour by the use of this machine is described as something extraordinary, the apparatus being capable of turning out rivets complete at the rate of forty to sixty per minute, with only two men to attend it.

THE CAPTAIN AND PART OWNER of the merchantman *Endeavour*, of about 2000 tons, bound on the Pacific, has adopted the following plan of defence in the event of a war breaking out with America.—"I take a sturdy picked crew, a supply of Enfields and six 18lb. Blakely guns, the latter sufficiently light to be easily handled by half a dozen men, so that fore or aft, larboard or starboard, as the case may require, the guns will point their muzzles. In the event of meeting with a Yankee letter of marque should heave to, receive his boats when in point-blank range with a couple of rapid discharges from my Enfields, and almost at the same time would let fly my Blakely's at the privateer's hull, and if I did not effectually damage her I would lead her a stern chase, peppering away at her so long as she remained within a two or three miles range. I have the most perfect confidence that with these long-range guns little short of a frigate can take me. Our own navy will see that few of those are roaming about; it is the host of mosquito letters of marque which we really have to prepare against. Being main owner of my vessel, I purpose insuring against ordinary sea risks only, dividing the war risks between self and crew. I do not fear but that they will stand by me and fight the vessel if needs must.

THE OIL SPRINGS OF AMERICA AND CANADA.—Mr. Alexander Macrae, of Liverpool, in a circular dated 16th ulto., says:—"The introduction of petroleum, kerosine, photogene, or rock and well oil, is making tremendous strides, though it does not surpass the prediction in my first circular, namely, that it would be second only in extent to cotton. I will even go a step further, and venture to assert that if the rocks and wells of Pennsylvania, Canada, and other districts continue their exudation at the present rate of supply, the value of the trade in this oil may even equal American cotton. Montreal (internally, and likely externally by this time), is lit with the white refined: and I can see no reason why London and Liverpool should not also be, for the oil gas distilled from the raw petroleum is immensely superior and much more brilliant than our own coal gas. For years we have sent coals to America for gas works, and it will be a singular freak of events if she and Canada should now supply us with a better expedient. Invested interests will perhaps stay it for the moment, but will they ultimately? The refined for burning (known in this country as paraffin oil, and of which about 500 tuns a week are sold), has been selling at £30 to £40 per tun (of 252 gallons) for yellow to white, while the crude varies in value from £6 to £25, according to test. The merits of the petroleum will be better understood when importers are informed that besids the uses already named, lubricating oils of every colour and specific gravity can be obtained from it; wax, also, for the manufacture of paraffin candles, naptha, and consequently benzole (from from which the fashionable dyes, magenta, rosenine, anneline, &c., are obtained) pitch, &c., all of them having several other applications. It is reported on the very best authority, that they have discovered from it now an available substitute for spirits of turpentine for paints, and also a solvent for india-rubber, results, I understand, that they have not effected in America and Canada, and the importance of which cannot be over-estimated. In my first circular it was stated that some 7000 barrels of crude and refined were on the way to this country, and the *Times* of the 13th inst., mentions 8000 barrels on the way to London. There are 10,000 barrels coming to Liverpool, and 2000 barrels to Glasgow, in all about 20,000 barrels (or £100,000 sterling, and the trade not six months old), a simple tithe of what we want! American hostilities and the ice in the St. Lawrence (although we have still St. John's New Brunswick) may stop supplies to some extent, but I have no doubt the future will vindicate the expectations I have so frequently expressed."

NEW COMPOSITION.—Mr. J. S. Manton, of Birmingham, has lately patented a new composition. It consists of mineral, earthy, arenaceous, or other like substances; animal shells of any kind, such as pearl or oyster, powdered glass or pebbles, marble, slate, basalt, slag, &c., are some of the substances used. These, being powdered, are mixed in certain proportions, and are amalgamated, under great heat, into a paste. In this state the material is capable of almost any application. It can be transferred to dies, and takes the sharpest possible impression of the most delicate ornament. It can be produced in almost any colour, and acquires a surface equal in polish and finish to the finest ivory, whilst it is pleasant and agreeable to the touch. Ornaments, picture frames, inkstands, chess and draughtsmen, fancy articles of every description, and buttons in any size or pattern, are a few of the uses to which the material can be applied.

NAVAL ENGINEERING.

THE "WARRIOR," 40, iron frigate, has been ordered to be supplied with eight of the Armstrong 100-pounders, which are to be substituted for eight of her 68-pounders that are situated forward and aft, out of her line of armour-plating. It is also intended to substitute the new naval pattern 70-pounder Armstrong as soon as possible for the ship's present complement of 40-pounder Armstrongs. The 70-pounders are said to be a very superior weapon, even to the Armstrongs at present in use for naval warfare. The *Warrior's* main-deck port lids have been taken off the ship's side and are being fitted with vulcanized india-rubber linings on their inner edges, to fit into the backstops of the ports and render them water tight.

THE "COLLINGWOOD," 81, screw steamship, 2611 tons, after being converted from a sailing ship into a steamer, tested her engines at the measured mile off Maplin Sands on the 3rd ult. The *Collingwood* is fitted with return connexion rod engines of 400 H.P., constructed on an improved principle by Messrs. Rennie and Son, and which worked in a very satisfactory manner. The vessel with full boiler power attained a mean speed of 10·415 knots, the pressure of steam being 23, revolutions 61, and vacuum 27. When tried with half boiler power, she attained a mean speed of 8·155 knots, the revolutions being 47½. In addition to this she turned the circle in 5 min. 13 sec., and the half circle in 2 min., 53 sec., the diameter of the circle being only four times the length of the ship. The temperature on deck was 46°; engine-room, starboard side, 53°; port side, 45°; stokehole, afterpart, 58; forepart, 71. Draught of water forward, 17ft. 6in. aft, 21ft., 4in. The vessel is fitted with Griffiths's screw, 19ft. 3in. pitch, diameter, 17ft.

THE "ORPHEUS," 21, screw, steamed out of Portsmouth harbour on the 3rd ult., to test her speed officially, at the measured mile at Stokes Bay. A strong breeze was blowing the greater part of the day, raising at times a rough sea. Like all vessels of the same class, the *Orpheus*, when under steam, depresses her head in the water, raises a huge continuous wave under her bows, and promises to be a remarkably wet and uncomfortable ship when contending against a head sea. The ship's draught of water prior to leaving the harbour, was 18ft. forward, and 19ft. 9in. aft. Four runs were made at the mile with full boiler power, the mean of which gave the ship a speed of 11·155 knots. Four runs were then made with half boiler power, the mean of these giving a speed of 9·204 knots, the revolutions of engines at full power being 63½, and at half power 51, the vacuum on condensers being 25½, and the pressure of steam 20.

"LA GLOIRE."—Advices from Paris and Toulon assert that the armour plates of this iron-plated frigate have become loosened upon her sides from the ship's working when at sea, and that she consequently leaks to such an extent when under steam that she is in reality unseaworthy. The quality of her armour-plates is also suspected to be of a very inferior character to those manufactured in this country. This last supposition has arisen from the fact of two armour-plates having been supplied to the Spanish Government by the firm which supplied those for *La Gloire* as specimen plates for testing, and which were said to be even superior to those supplied to the French Government. The Spanish Government tested the plates at 200 yds., with 8in. guns, and the result was that the plates broke in pieces each time they were struck by a shot.

THE "LEANDER," 51, 500 H.P., is ordered to be fitted with the following armament:—Main deck, eight 8in., 65 cwt. guns, eighteen 32-pounders of 58 cwt., and four 70-pounder Armstrong guns. Upper deck: 100-pounder Armstrong pivot gun, six 40-pounder Armstrongs, and fourteen 32-pounders, each of 45 cwt. The same armament is ordered to be supplied to the *Severn*, 51, the *Arethusa*, 51, and other screw steamers of that class.

THE "GALATEA," 26, 800 H.P., is to be supplied with the following powerful armament: Main-deck, twenty 10-in. guns, each of 84 cwt., and four 100-pounder Armstrong guns; upper-deck, two 100-pounder pivot guns.

THE LORDS OF THE ADMIRALTY having approved a scale of charges for the towage of Her Majesty's ships, transports, and other vessels to and from London, Woolwich, Gravesend, the Nore, and the Downs, it has been promulgated for general information. The scale of charges from London to the Downs varies from £38 to £107, according to the tonnage of the different classes of ship, from 600 tons to 1500 tons and upwards. Two tugs are only to be used when absolutely necessary.

THE "BOMBAY," 81, screw steamer of the line, which had been several months in hand, completed fitting at Chatham, on the 10th ult. The *Bombay* was built in the East Indies, and has just been lengthened at Chatham, converted into a screw steamer, and fitted with engines of 400 horse-power.

THE RATTLESNAKE screw steam corvette, 21 guns, 1,705 tons. which has recently been built at Chatham, was taken to Maplin Sounds on the 19th ult., for the purpose of trying her speed and machinery at the measured mile. The engines, which are 400 nominal horse-power, are constructed by Messrs. Ravenhill and Co. At the time the trial took place, the vessel had to contend against a very strong gale; notwithstanding, the results were most satisfactory,—viz., mean speed, 13·3 knots per hour; revolutions of engines, 86; pressure of steam 20lbs; vacuum, 25. With half boiler power, speed, 10·455 knots; pitch (Griffith's screw), 23ft. 6in., variable from that to 26ft.; diameter of screw, 16ft.; force of wind, 7.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last:—R. L. Canney, Chief Engineer, to the *Asia*, additional for the *Sharpshooter*; C. A. Bydder, Chief Engineer, to the *Asia*, additional for the *Inflexible*; E. Clements, Chief Engineer, to the *Satellite*; W. Waterfield, Engineer, to the *Spider*; J. Ritchiel, and J. Singer, First-Class Assist. Engineers to the *Satellite*; J. Jolly, in the *Hanibal*; promoted to Engineer; W. H. Green, First-Class Assist. Engineer, to the *Sheldrake*; G. L. Thompson, First-class Assist. Engineer, to the *Spider*; E. W. Thomas, and R. J. Hancock, Second-Class Assist. Engineers, to the *Sheldrake*; W. Kelley, Second-Class Assist. Engineer, to the *Satellite*; J. R. Beer, Acting Second-Class Assist. Engineer, to the *Spider*; J. Edmonds, Acting Second-Class Assist. Engineer, to the *Satellite*; G. Griffith, Engineer to the *Indus*, as supernumerary; F. Lewis, Engineer, to the *Greyhound*, vice Griffiths; J. Leathlan, Engineer to the *Indus*, for the *Sparrow*, vice Lewis; G. Batchelor, Acting Engineer, to the *Cumberland*, additional for the *Britomart*; J. T. Page, First-Class Assist. Engineer, to the *Cumberland*, additional for the *Sandfly*; G. F. Lewis, First-Class Assist. Engineer, to the *Asia*, as supernumerary; J. M. Smith, Chief Engineer, additional to the *Meander*; G. Hutcheson, Chief Engineer, to the *Cumberland*; W. Burgess, in the *Waterman*, to *Engineer*; A. Clark, First-Class Assist. Engineer, to the *Volcano*; C. Bulford, in the *Urgent*; to First-Class Assist. Engineer; R. C. Oldknow, Second-Class Assist. Engineer, to the *Edgar*; J. Wood, Acting Second-Class Assist. Engineer, to the *Spider*; T. Griffiths, Acting Second-Class Assist. Engineer, to the *Cumberland*; W. M'Neill, Acting Second-Class Assist. Engineer, to the *Hogue*; J. M. Ollis, Chief Engineer, to the *Defence*; W. Collier, Engineer; T. Hartly, S. T. Wallis, and T. Green, First-Class Assist. Engineers, to the *Defence*; J. R. Harvey, Second-Class Assist. Engineer, to the *Cumberland*, for the *Cochin*; J. Wilson, Second-Class Assist. Engineer, to the *Asia*, for the *Echo*; A. Forrest, Acting Second-class Assist. Engineer, to the *Cumberland*, for the *Julia*; W. Williams and T. Stewart, Acting Second-class Assist. Engineers to the *Defence*; W. Williamson, to Engineer in the *Porpoise*; W. H. Roberts, to Acting First-class Assist. Engineer in the *Cæsar*; W. Harwood, to Acting First-class Assist. Engineer in the *Algiers*; J. Wyllie, Second-class Assist. Engineer, to the *Indus*, for the *Nightingale*; A. Brown, Second-class Assist. Engineer, to the *Indus*, for the *Gleaner*; F. E. Shean and L. Dingwall, Acting Second-class Assist. Engineers to the *Cumberland*, as supernumeraries; J. Ferguson, Acting Second-class Assist. Engineer, to the *Cumberland*, for the *Galatea*; C. S. Edrye and S. Scott, Acting Second-class Assist. Engineers, to the *Topaz*; J. Legate, Acting Second-class Assist. Engineer, to the *Termagant*; G. Woollard and R. Phillips, Second-class Assist. Engineers, to the *Bacchante*; G. S. Thunder and C. F. Jordan, Chief Engineers, to the *Devastation*; J. Lovering, Acting Chief Engineer, to the *Stromboli*; R. Wallace, First-class Assist. Engineer, to the *Devastation*; W. Chase, First-class Assist. Engineer, to the *Supply*; J. Young and W. H. Nurse, First-class Assist. Engineers, to the *Stromboli*; W. Bird, confirmed First-class Engineer; R. Oliver and C. G. Miller, Second-class Assist. Engineers, to the *Devastation*; W. Gair, Second-class Assist. Engineer, to the *Stromboli*; H. Rigby, Acting Second-class Assist. Engineer, to the *Asia*, for the *Sutlej*; J. Kelly, Acting Second-class Assist. Engineer, to the *Cumberland*, for the *Bullfrog*; E. Hocken, Acting Second-class Assist. Engineer, to the *Indus*, for the *Phebe*; John Muther, Engineer, and S. Lloyd, Acting Second-class Assist. Engineer, to the *Investigator*; J. Oliver, Chief Engineer, to the *Orlando*; J. King, Engineer, to the *Indus*, for the *Prospero*; F. W. Sutton, Engineer; R. W. Watson, First-class Assist. Engineer; A. Lawton, Acting First-class Assist. Engineer; W. B. Trenwith, Second-class Assist. Engineer; J. Craig and A. Gibson, Acting Second-class Engineers, to the *Orlando*; G. Booth, Engineer, confirmed, in the *Imperieuse*; J. Lawler, Acting Engineer, to the *Indus*; W. Fenton, Acting First-class Assist. Engineer, to the *Indus*, for the *Trinculo*; T. M. Thompson, Second-class Assist. Engineer, to the *Indus*, for the *Charon*; A. Wilson, Acting Second-class Assist. Engineer, to the *Indus*, for the *Prospero*; A. Gray, promoted to First-class Assist. engineer in the *Arrogant*; D. Crichton, confirmed in the *Edinburgh*; E. Watson, Acting Second-class Asst. Engineer to the *Asia*, as supernumerary; F. W. Sutton, Chief Engineer to the *Cumberland*, for the *Vixen*; J. C. Sanders, H. D. Garwood, A. Hindmarsh, R. Dillon, J. Boswell. R. D. Champion, F. Gundry, W. Rumble, promoted to the rank of First-class Asst. Engineers. Thos. Builions, Chief Engineer to the *Asia*, for the *Hannibal*; J. Jolly, First-class Assist. Engineer, and D. C. Miller, Second-class Assist. Engineer, to the *Fisgard*, as supernumeraries; B. Carr, Second-class Assist. Engineer to the *Indus*, as supernumerary; F. Brockton, Engineer; C. Jackson, Acting First-class Assist. Engineer; W. Hammond, and J. Jenkins, Second-class Assist. Engineers to the *Vigilant*.

THE AMERICAN IRON-CLAD FRIGATE, STEVENS'S BATTERY.—When Mr. Stevens first contemplated the idea of an armour-coated frigate, his object was not so much to stop an enemy's shot as to have his plates at such an angle as would give them a different direction. For this purpose he determined that the armour should not be laid at a less angle than 30 degrees, and that the plates should be of 6in. thickness, which, at such a slope, he calculated would be equal in resistance to a foot in thickness placed upright. With armour of such immense solidity a deep immersion of the ship became inevitable, and to do away, therefore, with the necessity for coating her too heavily or over too large a surface, he devised a method by which the ship, when going into action, could instantly fill her compartments with water, so as to bring her down almost completely under the sea, submerging all but the funnel and the ridge of guns on the apex of the slanting armour plates, which cover in her deck much after the fashion of a common ridge roof. Mr. Stevens, in fact, considered water as the cheapest and most thorough protection to be found against the flight of projectiles, on account of its perfect non-elasticity. The principal dimensions are:—

Length over all	420 feet
Breadth of beam over all	53 „
Breadth, exclusive of armour	45 „
Depth from main deck	21 „
Depth to upper or gun deck	24 „
Minimum draught of water	16 „
Draught in fighting trim	21 „
Tonnage	5,000 tons
Weight of engines	548 „
Weight of boilers	266 „
Weight of hull	1,447 „
Weight of armour and loading-houses	2,000 „
Weight of eight guns and carriages	198 „
Weight of coal (entire capacity)	900 „
Water to immerse to 21ft.	923 „
Immersion without water	17 feet
Area of midship section at 21ft.	810 „

the two sets of engines is of about 1000 nominal horses' power, so that working the screws at the rate of 100 revolutions a minute will give an indicated power of 8000 horses. The armour plates rise to a height of only 8ft. above the water-line when the ship is fully immersed to her fighting trim, and here the guns stand on a ridge or platform of metal, about 25ft. wide in the stern, and from 15ft. to 12ft. wide in the bows. On this armour deck are placed eight guns of wrought iron—the four in the bows being 15in. shell guns, throwing a shell some 350lbs. weight; the four in the stern being 18in., and throwing shells of more than 500lbs. In addition to these are four angular and almost conical loading-houses (covered, like the rest of the armour deck, with 6-in. plates), one being built between each gun fore and aft. The guns themselves are left entirely exposed, their trunnions being bedded into enormous hemispheres of wrought iron. Each of these hemispheres forms part of a turn-table, which is worked on the 21ft. deck beneath. The whole theory on which she would fight, therefore, is,—on the approach of an enemy the vessel would immerse itself by taking in water till the ridge of her gun deck was almost level with the water's edge. The men told off for loading would occupy the loading-houses, and those beneath would, with the aid of the turn-table, work round the muzzle of each gun to the entrance of the loading-house, so that each piece might be loaded, worked round again, and fired as quickly as possible. Ports, or doors, sufficiently thick, as it is thought, to close the entrance of the loading-houses against ordinary shell protect the men inside when they have once loaded, but the gun itself, with all the men engaged in elevating and firing it, is left entirely exposed.

THE DEFENCE.—The iron masts and bowsprit of this iron-clad steamer have arrived at Chatham. Each mast is of great apparent strength, the weight of the lower mainmast and fittings being 16 tons; that of the foremast, 15 tons and the mizen-mast, 6½ tons; the iron bowsprit weighs exactly 4¾ tons.

AMERICAN IRON-CLAD FRIGATE.—There is now being constructed for the Government, in the shipyard of Messrs. Cramp and Son, Philadelphia, an iron-clad screw frigate. The vessel will be 230ft. long; 60ft. beam; 25ft. hold; having three full decks. When loaded she will draw 15ft. water, and will carry sixteen 11-inch guns. She will have two powerful engines, and one large brass wheel, and is expected to attain a speed of 10 knots per hour. The plates are 15ft. long, 28½in. and 30½in. wide, and 4in. thick. After being received at the foundry, the plates are planed, the edges and ends being made straight and smooth, are grooved like a flooring board. The groove is 1in. wide by ½in. deep. Screws are to be used in fastening the plates to the planking of the ship. They are to be put in from the inside of the vessel, and are not to go through the plates. The vessel is to be covered with plates four feet under water and three feet above it, and they are to extend 85ft. fore and aft of the centre line, which will make 170ft. of planking. The sides of the ship are to have an angle of 30 degrees from 3ft. above the load lines. The tonnage is to be 3500.

STEAM SHIPPING.

THE PENINSULAR AND ORIENTAL STEAM NAVIGATION COMPANY.—The annual meeting of this company was held on the 4th ult., when a dividend was declared of 3 per cent., together with a distribution of 3½ out of the underwriting account, making a total of 6½ per cent., free of income tax. It was stated that since the last report, four unserviceable ships have been disposed of, while orders are now being executed for three large iron steamers. The *Mooltan*, the last new steamer, which had been fitted up with superheating apparatus, and other improvements for the saving of coals, has made two trips between Southampton and Alexandria, and had attained a highly satisfactory rate of speed with a consumption of only half the ordinary quantity of fuel. Annexed is a list of the company's fleet, in addition to which there are three screw steamers building of a total of 6400 tons and 1300 H.P., and eight transport, store, and coal ships of 10,277 tons, making a total of 83,385 tons, and 17,771 H.P.:—

	Tons (Customs' Measurement.)	Horse-power.	Service.
1. Simla, s.	2440	630	Calcutta and Suez.
2. Columbian, s.	2352	500	Suez, Bombay, and China.
3. Mooltan, s.	2557	400	Southampton and Alexandria.
4. Bengal, s.	2185	465	Calcutta and Suez.
5. Colombo, s.	2127	450	Calcutta and Suez.
6. Nubia, s.	2095	450	Calcutta and Suez.
7. Ceylon, s.	2020	450	Southampton and Alexandria.
8. Nemesis, s.	2018	600	Calcutta and Suez.
9. Hindostan, p.	2017	520	Calcutta and Suez.
10. Pera, s.	2014	450	Southampton and Alexandria.
11. China, s.	2010	400	Suez, Bombay, and China.
12. Candia, s.	1982	450	Calcutta and Suez.
13. Indus, p.	1950	450	Southampton and Alexandria.
14. Malta, s.	1942	500	Calcutta and Suez.
15. Orissa, s.	1646	300	Suez, Bombay, and China.
16. Massilia, p.	1640	400	Marseilles and Alexandria.
17. Jeddo, s.	1632	450	Suez, Bombay, and China.
18. Delta, p.	1618	400	Southampton and Alexandria,
19. Behar, s.	1603	300	Suez, Bombay, and China.
20. Ellora, s.	1573	300	Southampton and Alexandria.
21. Emeu, s.	1538	300	Suez, Bombay, and China.
22. Salsette, s.	1491	400	Ceylon and Sydney.
23. Benares, s.	1491	400	Ceylon and Sydney.
24. Pottinger, p.	1350	450	Suez, Bombay, and China.
25. Northam, s.	1330	400	Ceylon and Sydney.
26. Ottawa, s.	1274	200	Suez, Bombay, and China.
27. Singapore, p.	1190	470	Suez, Bombay, and China.
28. Ganges, p.	1190	470	Suez, Bombay, and China.
29. Bombay, s.	1186	275	Suez, Bombay, and China.
30. Madras, s.	1185	275	Suez, Bombay, and China.
31. Pekin, p.	1182	400	Suez, Bombay, and China.
32. Euxine, p.	1165	400	Marseilles and Alexandria.
33. Sultan, s.	1124	210	Marseilles and Alexandria.
34. Norna, s.	991	230	Suez and Mauritius.
35. Valetta, p.	832	260	Marseilles and Alexandria.
36. Cadiz, s.	816	220	China Coast.
37. Aden, s.	812	210	China Coast.
38. Nepaul, s.	796	200	Suez and Mauritius.
39. Tagus, p.	782	286	Peninsular.
40. Vectis, p.	751	260	Marseilles and Alexandria.
41. Azoff, s.	700	180	China Coast.
42. Formosa, s.	675	155	Chartered to French Govt.
43. Alhambra, s.	642	140	Peninsular.
44. Granada, s.	561	160	Chartered to French Govt.
45. Shanghai, s.	546	100	Chartered to French Govt.
46. Union, s.	340	60	Red Sea Lighthouse Service.
47. Mazagon, p.	86	45	Bombay Harbour.
48. Ripon, p.	1583	450	Under repair.
	66708	16471	

THE "INVESTIGATOR," paddle-wheel steamer, built at Deptford, for Dr. Livingston's expedition up the Zambesi, underwent, on the 3rd ult., an Admiralty trial of her machinery, which was in all respects satisfactory. The engines at full speed yielded 10·6 knots per hour.

THE IRON STEAMBOAT COMPANY'S steamer, *Warrior*, was launched on the 16th ult. from the works at Nine Elms. The dimensions of this vessel are 107ft. between perpendiculars, 14ft. beam, and 6ft. 6in. deep. She will be fitted with a pair of oscillating engines of the nominal power of 24 horses.

THE "ANCONA," a fine steam dredger of 300 tons, was launched at Southampton on the 14th ult., from the yard of Messrs. C. A. Day and Co. She is for service at Ancona, and is to sail out and carry in her, in parts, two barges of 100 tons each, and the whole of the constructions have all the recent improvments, and after the models of similar vessels that have proved so successful at Malta.

THE "PERU."—The Pacific Steam Navigation Company's new iron mail steam-ship arrived on the 20th ult., in the Mersey, from the Clyde, having run the distance from the Clock Lighthouse in 14 hours, exclusive of stoppage for water to cross the bar. The vessel during the run attained a speed of 15 knots, with 33lb. pressure of steam, 23½ revolutions of engines per minute, and at a consumption of 30 cwt. of Scotch coal per hour. Immediately on the *Peru's* arrival, the Government Inspectors proceeded on board, and the vessel started on a trial to the Bell buoy, when she attained a speed of 14½ miles per hour, with 35lb. pressure of steam, and 24½ revolutions per minute. The vessel was built by Messrs. John Reid and Co., of Port Glasgow. The machinery is on the double cylinder principle of Messrs. Randolph, Elder and Co,, of Glasgow, and is the tenth pair of engines supplied to the Company by that firm.

STEAM-SHIP PROPELLER.—A propeller, re-invented by Mr. C. G. Gumpel, M.E., was exhibited and tried on the lake in the Surrey Gardens, on the 9th ult. Beneath the bottom of the vessel is placed a rectangular channel, expanding in the central part. Above this central part are placed two cylinders, or pumps, so arranged that, while one pump is drawing water the other is expelling it. There is also in the chamber a valve, which directs the water to and from the pump so that the water entering is drawn through the fore opening of the channel, and that, leaving, is forced through the after opening, both these openings being capable of adjustment as to area. Notwithstanding the difficulties attending the trial, due to the bad form of the boat, and insufficiency of boiler power, the propellor appeared to be successful, the water in the wake of the vessel remaining almost undisturbed.

RAILWAYS.

RAILWAY BILLS FOR 1862.—The plans and sections of proposed works specified in the following railway bills have been deposited at the Board of Trade for the ensuing session of Parliament:—Abbeyholme, Leegate, and Bolton; Aberystwith and Welsh Coast; Alford Valley; Andover and Great Western; Andover and Redbridge; Andover, Redbridge, and Southampton. Bala; Bala and Dolgelly; Balham and Putney Junction; Banstead and Epsom Downs; Barnesley Coal; Berwickshire; Birkenhead; Birkenhead, Flintshire, and Holyhead; Birkenhead and West Cheshire Junction; Bishop Walton, Botley, and Bursledon Down; Bognor, Chichester, and Medhurst; Bradford, Wakefield, and Leeds; Breandown and Weston-super-Mare; Brecon, and Merthyr Tydvil; Bridge of Weir; Bristol and South Western Junction; Bristol and Clifdon; Bristol Port and Pier; Bristol and South Wales Union. Caledonian (branches); Caledonian (deviations); Cannock Chase Extension; Cannock Mineral Extension; Carmarthen and Cardigan (extension and branches); Carnarvonshire; Carlow, Tullow, and Newtonbarry; Cork and Youghal; Cork, Middleton, and Fermoy; Corwen, Bala, and Port Madoc; Cowbridge, Cowes, and Newport; Crystal Palace and South London; Daventry Extension; Dayton Junction; Deeside Extension; Dowlais Valley Mineral; Dove Valley; Dublin Metropolitan; Dundalk and Enniskillen (Extension). Eastern Counties (Wisbeach and Peterborough); Eastern Counties (Extension at Colchester); Eastern Counties (new lines in Middlesex); East Gloucestershire; East Grinstead; Groombridge and Tunbridge Wells; Eden Valley; Edgware, Highgate, and London; Edinburgh, Dunfermline, and Perth Junction; Edinburgh and Glasgow (Extension); Ellesmere, Ruabon, and Shrewsbury; Ellesmere, Oswestry, Ruabon, and Shrewsbury; Enniskillen and Bundoran (Extension to Sligoh). Fermoy, Lismore, and Dungarvon; Frosterley and Stanhope; Furness. Garston and Liverpool (Deviations); Glasgow and Renfrew Junction; Great Northern, No. 1; Great Northern, No. 2; Great Northern and Western of Ireland; Great Western (additional powers); Greenock and Wemyss Bay. Hammersmith, Brentford, and Kew; Hatfield and St. Albans; Hereford, Hay, and Brecon; Holbeach Junction; Horsham, Dorking, and Leatherhead; Hull and Hornsea; Hull and West Riding Junction. Isle of Wight. Keighley and Worth Valley; Kent Coast; Kensington Station and North and South London Junction; Kettering and Thrapstone; Kington and Eardisley. Lancashire and Yorkshire (Doncaster, Goole, and Hull Junction); Lancashire and Yorkshire (additional powers); Launceston and South Devon; Leeds, Bradford, and Halifax Junction; Ledbury and Gloucester; London, Brighton, and South Coast (enlargement of stations); London, Brighton, and South Coast (new lines); London and Blackwall; London, Chatham and Dover (junction at Battersea); London, Chatham, and Dover (extension to Walmer and Deal); London, Edgware, and Bushey; London and Midland; London and North Western (additional powers); London and South Western (additional powers); London and South Western and Andover and Redbridge; Lostwithiel and Fowey; Llanidloes and Newton, Mid-Wales, and Manchester and Milford; Llanelly; Lymington; Linton and Dolphinton. Manchester, Sheffield, and Lincolnshire (additional powers); Manchester, Sheffield, and Lincolnshire (central station in Liverpool); Manchester and Milford (Rhayader branch); March and Askern; Marton and Hanbury; Maryport and Carlisle; Market Drayton and Newport; Metropolitan; Metropolitan and Thames Valley; Merionethshire; Midland (Rowsley and Buxton); Mid-Wales (deviations); Mid-Wales (branch); Mid-Wicklow; Mid-Kent and Addiscombe; Mid-Sussex and Midhurst Junction; Mold and Wrexham; Mortonhampstead and South Devon. Nantille; Newport and Ryde Direct; Newcastle (deviation); North British (Monkton Hall, Omristown and Dalkeith Branches); North Devon and Okehampton; North Eastern (Market Weighton, Beverley and Hull Branch); North Eastern (Hull and Doncaster); North Eastern (Blaydon to Conside); North Eastern (Branch Valley); North Metropolitan Junction; Norwich and Spalding. Oswestry, Ellesmere, and Whitchurch; Oswestry and Newtown, Llanidloes and Newtown, and Shrewsbury and Welchpool; Oswestry, Shrewsbury, and Ellesmere. Parsonstown and Portuma, Radstock and Keynsham; Ramsgate, Sandwich, Deal, and Dover; Rickmansworth, Amersham and Chesham. Sevenoaks; Severn and Wye; Scottish Central; Scottish Northern Junction; Scottish North Eastern; Shrewsbury and Hereford; Shrewsbury and Welchpool; Sidmouth; South Eastern (Tunbridge and Dartford lines); South Yorkshire (Sheffield and Thorne); South Yorkshire (extension to Hull); South Leicestershire (deviations); Southampton and Netley; Southampton and Isle of Wight; South Staffordshire and Central Wales (Dudley and Bridgnorth); Spalding and Bourn; Stamford and Essendine; Stafford and Uttoxeter; Stockton and Darlington (Towlaw and Crook); Swansea, Neath, and Brecon Junction. Tendring Hundred; Tewkesbury and Malvern; Thames Embankment (North and South); Tottenham and Hampstead Junction. Uxbridge and Rickmansworth (deviation.) Vale of Clwyd; Victoria and Pimlico. Waterford and Limerick and Limerick and Ennis; Wellington and Cheshire Junction; Wellington, Drayton, and Newcastle; West Cheshire; West Hartlepool (Dock extension); West Galway; West Riding, Hull and Grimsby; West Midland (Merthyr, Tredegar, and Abergavenny, lease and extension); West Midland (additional works); West Shropshire Mineral; Whitchurch, Wrexham, Mold, and Connah's-quay Junction; Weymouth and Portland.

OTTOMAN RAILWAY.—The first section of this line has been opened from Smyrna to Koosboonar, and has been officially accepted by the Turkish Government.

THE GRAND TRUNK OF CANADA report includes the accounts for the half year ending 29th June last, showing a balance over working expenses of £46,785, which has been applied to the part payment of the rents and arrears due on the leased lines, amounting to £73,589.

THE CALEDONIAN RAILWAY proprietors have resolved to raise £484,550 of new capital, already authorised, for the construction of certain stations and branch lines. £148,200 more are also to be raised on mortgage.

CHARING CROSS RAILWAY COMPANY.—The award of Mr. John Stewart, of Liverpool, the umpire appointed by the Board of Trade, has been made for compensation to be paid by the Charing Cross Company for the purchase of St. Thomas's Hospital and premises, and also for the damage sustained by the governors by reason of the execution of the works authorised by the Company's Act. The sum awarded by the umpire as compensation, on the grounds stated, is £296,000. The claim of the authorities connected with the hospital, it will be recollected, was £750,000.

FRENCH RAILWAYS.—It appears from a return made by the Minister of Public Works, that the total traffic receipts on the railways in France for the nine months ending 30th September last, amounted, on 6147 miles, to £13,348,462, and for the same period of 1860, on 5832 miles, to £11,918,501, showing an increase of £1,429,961, or 8·78 per cent.

OPENING OF THE CLEVELAND RAILWAY.—The new line of railway from the Tees to Skelton, in Cleveland, was opened, on the 23rd ult., for traffic. The line is connected with the North Yorkshire or Cleveland system of railways, and has been made with a view to open out a rich agricultural district, and to develope the great mineral resources of the hills lying along its course. It is ultimately intended to carry the line to Skinningrove, a few miles beyond.

THE SOUTH-WESTERN RAILWAY EXTENSION TO BRISTOL.—It has been determined by this company to bring the extension into the very centre of the city, by making the station at the Stone Bridge, near the end of Small-street. This decision comes too late for the present Parliamentary application. But it will be carried into effect upon the earliest opportunity.

RAILWAY ACCIDENTS.

ACCIDENTS ON FRENCH RAILWAYS.—On the Northern, Strasburgh, Western, Orleans, and Mediterranean lines of railway, 2.130 trains run every day, and the distance performed is altogether 192,000 kilometres (⅝ths of a mile each), making a total of 777,450 trains, and more than seventy millions of kilometres in the year. The number of passengers conveyed on those lines in the years from 1850 to 1860 was about 310 millions, and during that period the loss of life by accidents was forty-four, or one out of seven millions. Does there exist a human undertaking where material forces are used in the midst of difficult circumstances and with the co-operation of such a considerable number of men, which would engage not to make a greater number of victims? The above figures, taken from official sources, have an eloquence which cannot be easily weakened, and against which affirmations too lightly brought cannot prevail. What additional force do not these calculations acquire when they are compared with the number of carriage accidents which take place in one year in the public throughfares of Paris alone? In 1860, for instance, the official statistics inform us that the casualties of that kind amounted to 920, which occasioned the death of thirty persons, and serious injuries to 579 others. Thus the circulation of carriages in Paris has led to almost as many violent deaths in one year as the circulation on the French railways in ten years.

ACCIDENT ON THE SOUTH-WESTERN RAILWAY.—An accident took place on the South-Western Railway on the evening of the 6th ult., at the Portswood-station, about two miles from Southampton. It appears that the wife of one of the railway telegraph inspectors had just descended the steps leading from the bridge on to the line at the temporary station recently erected at Portswood, and was about to cross the main line just as the signal was put on for the five o'clock down train from London to pass. Mr. Noakes, the station-master at Portswood, seeing the imminent danger in which she was, ran across the line to save her, and just reached her and pushed her backwards out of harm's way, but unhappily the buffer of the engine caught the unfortunate man's shoulder and hurled him nearly 50ft. along the line, killing him on the spot.

ACCIDENT AT THE BANBURY STATION ON THE GREAT WESTERN RAILWAY.—On the evening of the 4th ult. an accident occurred opposite the Gas House, within a short distance of the Banbury station. It appears that the 3.40 train from Paddington, due at Oxford at 5.48, arrived within a few hundred yards of the Banbury station at its proper time. When opposite the Gas House it came into collision with some trucks, which the company's servants were in the act of shunting. The speed at which the passenger train was going was considerable, it being what is termed a "fast" train, stopping at but few intermediate stations. Two of the trucks were completely demolished, the engine and tender ran off the line on to the embankment, the glass in some of the carriages was broken, and the passengers received a severe shock.

MILITARY ENGINEERING.

ARMSTRONG GUNS.—Some further experiments with these guns have taken place, under the direction of the Ordnance Select Committee, when two 100-pounder guns of the ordinary service pattern fired a large number of consecutive rounds at the Woolwich butts. The rapidity of firing was nearly uniform throughout. One 100-pounder fired its last fifty rounds in 34½ min., and the other fired fifty rounds in 33½ min. This includes every stoppage. The guns were not sponged for seventy or eighty rounds respectively, and remained clean to the end. There was no escape whatever of gas from the breech.

THE 100-POUNDER ARMSTRONG GUNS, the issue of which had been temporarily suspended during some experiments, are again being delivered for service. These guns have also been successfully fired with shells filled with molten iron. The Armstrong shell, when employed for this purpose, is lined with a non-conducting material, which effectually confines the heat, and prevents it from in the slightest degree injuring the outer covering during the interval required for loading.

TELEGRAPHIC ENGINEERING.

PACIFIC TELEGRAPH.—The completion of this telegraph, by which the Atlantic and Pacific slopes are joined, is announced. The completion of the last link of the American telegraph connects Cape Race with the Golden Horn, traversing nearly 5000 miles with one continuous wire, and bringing these two points within two hours telegraphic time of each other. The next westward extension of this line will be by the way of Behring's Straits to the mouth of the Amoor River, to which point the Russian Government is already constructing a line commencing at Moscow. San Francisco is now at one end of the longest telegraphic line in the world—70 degrees of longitude—St. John's (Newfoundland) being in 52 degrees 43 minutes longitude west Greenwich, while San Francisco is in 122 degrees.

BRIDGES.

THE DUBLIN CORPORATION are contemplating the rebuilding of Carlisle Bridge, the great thoroughfare between the north and south of the city. It is proposed to make it the whole width of Sackville-street, with an arch on the model of Westminster-bridge. The cost would be between £40,000 and £50,000.

THE NEW ST. PATRICK'S BRIDGE, CORK, has been opened. From the inside of one balustrade to the inside of the other, it measures 60ft. 6in.; 10ft. will be taken off each side for foot-paths, which will be constructed of granite. In the entire length of the bridge, 222ft., the rise in the level is only about 2ft. As to cost: it appears there are 13,875 superficial feet, which have been built for £14,500, or about £1 1s. a foot.

The Girders of the Lendal Bridge, York.—These girders have been sold by tender, and have been in the course of removal during the week. The girders and other iron-work have fallen to the tender sent in by the engineer of the North-Eastern Railway Company, at £2 10s. per ton, and the total purchase money will be about £700.

New Iron Bridge at Northenden, Cheshire. The ferry-boat, which has been in use on the Mersey at Northenden, is now superseded by a lattice girder foot-bridge. This structure consists of two wrought iron lattice girders, spanning the river, which is 83ft. wide at this point. The girders are of ornamental design, 88ft. long, 6ft. deep in the centre, and 2ft. 6in. at the ends; and they are placed 6ft. apart; the footway being composed of cross timbers and planking. Each end of the bridge is supported by a cluster of four pile columns, 8in. diameter, which are driven 15ft. into the earth. The upper parts of the girders are connected in two places by cast-iron arches.

GAS SUPPLY.

Great Western Railway and London Gas.—The Paddington railway station is now supplied with gas from works which have been put into operation during the last two years at Wormwood Scrubs, Kensal-green, built on some waste land at the side of that line. The land was given by the railway company on condition that the Paddington station and hotel should be supplied with gas at the rate of 2s. 10d. per 1000 cubic feet. Mr. Gooch, locomotive superintendent, has charge of these gas works. Wallcot's patent gas retort bed has been put up, built in the space, it is stated, which previously only contained the power to generate one-third the gas which can now be made.

BOILER EXPLOSIONS.

The Association for the Prevention of Steam Boiler Explosions.—At the last ordinary monthly meeting of the executive committee of this Association, held at the offices, 41, Corporation-street, Manchester, on Tuesday, November 26th, 1861—William Fairbairn, Esq., C.E., F.R.S., President, in the chair—Mr. L. E. Fletcher, chief engineer, presented his monthly report, from which we have been furnished with the following extracts:—"During the past month 315 engines have been examined, and 436 boilers, 6 of the latter being examined specially, 8 internally, 22 thoroughly, and 400 externally, in which the following defects have been found:—Fracture, 2; corrosion, 25 (2 dangerous); safety valves out order, 7 (2 dangerous); water gauges ditto, 9 (3 dangerous); pressure gauges ditto, 6; feed apparatus ditto, 3; blow-off cocks ditto, 40; fusible plugs ditto, 1; furnaces out of shape, 10 (3 dangerous); deficiency of water, 2; over pressure, 4; boilers without safety valves, 1 (dangerous); total, 110 (11 dangerous). Boilers without glass water gauges, 18; ditto without pressure gauges, 19; ditto without blow-off cocks, 9; ditto without feed-back pressure valves, 39. I have examined some boilers this month which have given considerable trouble from leakage, and rendered extensive repairs necessary, which might have been prevented had they been throughly tested by hydraulic pressure at the outset, and I think our members would do well to make more frequent use of this test than they do, not only on laying down new boilers, but also on re-starting those that have undergone repair, as well as in periodically ascertaining the safety of those that have been at work for years; I would recommend in all cases that boilers should be proved in this way to a pressure 50 per cent. higher than that at which they are to work, and that this test should be applied not for a short time only, but be maintained steadily for at least half a day, care being taken to prevent all concussion, since otherwise irregular and injurious strains may be put upon the boiler. No boiler should be set in the brickwork until thoroughly tight throughout, when, if well made and taken proper care of, it would last an indefinite time. It is, however, too frequently the case, that boilers are bricked in, either untested, or trusting that such small leaks as may appear will take up of themselves when in actual work, instead of which, the water once finding a way through, enlarges its channel and corrodes the plate in the neighbourhood of the leak; this frequently eats away the surface so smoothly and evenly that the thinning of the plate escapes detection, and I met sometime since with a case of explosion, from which several lives were lost, that resulted from this cause, and which might have been prevented by the timely application of the hydraulic test. I have met during the last month many safety-valves having their levers improperly loaded; I do not say overloaded, but improperly loaded, having several irregular weights, and these often insecurely attached, and would recommend in each case that only a single weight should be employed, and that placed either at the end of the lever, or, if midway, pinned in position, so as to prevent any increase of pressure beyond that decided on by the owner of the boiler. On the owner must rest the loss and onus of accident; therefore his should be the decision and control. The inspectors are instructed at each visit to apply their indicators when the steam is blowing off, so as to ascertain the actual pressure at which the safety valves are loaded. To this I attach considerable importance, and am desirous that it should be done in every case; and trust that those members who have not already done so will co-operate with me by providing their boilers with taps, suitable for the application of the indicator we use, which is McNaught's quarter-inch."

MINES METALLURGY, &c

Manufacture of Shear Steel.—Steel obtained by the process of puddling, and known as puddled steel, and steel iron, is found not to answer all the purposes to which it might be applied, for want of uniformity and homogeneity; puddled steel, as well as raw steel, is, therefore, either formed into cast steel by refining into shear steel. As an improvement upon this mode of manufacturing shear steel, Mr. William Spielfield, of Westphalia, has patented an invention which consists in protected puddled steel and raw steel against the action of the gas developed from the fuel, as well as against the action of atmospheric air, while the puddled or raw steel is exposed to welding heat, or the highest heat which it can stand without being melted. For this purpose lumps or piles of puddled steel, or of raw steel, are placed in retorts or vessels made of fire-proof materials. The opening into the retort is then closed by a lid, with a sight-hole in it, and the retort is placed in a furnace to be heated; by preference, a retort of prismatic form if used. The lid should cover the opening into the retort as accurately as possible. The sight-hole in the lid communicates with a sight-hole in the furnace door, so that the workman can at any time watch the steel within the retort without opening the furnace door, or removing the lid of the retort. When the steel has become properly heated its surface presents a silver-like appearance, and the interior of the retort appears of a bluish-white colour. The time during which the steel is kept in this state of heat must not be too short, and cannot be too long, provided the heat be not increased to such a degree as will fuse the steel. After some time, which experience will dictate, the steel is taken out of the retort, and hammered and rolled, and the result is a high-quality shear steel, applicable for cutlery, wire plates, and other purposes.

Aberdare Colliery Company.—A prospectus has been issued of this company, with a capital of £100,000, in £10 shares. The object is to purchase and work certain collieries, comprising 800 acres, in Glamorganshire, with railway access to the port of Cardiff. The coal produced in this district is especially adapted for steam purposes.

APPLIED CHEMISTRY.

On Formic Acid.—By M. Jacobsen.—Formic acid, prepared from starch and neutralised with carbonate of strontia, produces, as is known, fine crystals of formiate of strontia with two equivalents of water, which are hemihedral, some being right-handed and others left-handed. M. Pasteur, who noticed this fact, equally remarked that the aqueous solution of this formiate has no action upon polarised light, which he explains by the presence of the two hemihedral forms. When prepared from oxalic acid and from glycerin, formic acid gives rise to a formiate of strontia similar to the preceding at least in appearance, but which nevertheless differs sufficiently from it to prevent the admission of the absolute identity of the two acids, and consequently the two salts. The former formiate gives in preference left-handed hemihedral crystals, while the crystals produced by the formiate from glycerin is especially distinguished by right-handed hemihedral facets, the left-handed facets being in this instance in quite a subordinate proportion, while in the formiate from starch the left-handed facets preponderate.

Sulphur in California.—The refining of sulphur has been commenced as a business in Santa Barbara county, Cal. Twenty miles south-eastward of the town of Santa Barbara, and seven miles back from the Mission of San Buenaventura, which is upon the sea shore, is a great bed of native sulphur, deposited in remote ages by the vapours and waters of sulphur springs. The country in the vicinity bears strong marks of volcanic action. The sulphur deposits back of San Buenaventura have long been known, but only lately has it been rendered valuable. Messrs. Davidson, Spence, and Co., commenced about the first of this year to open the mine, and at that time there were then some half-a-dozen men at work in the mine, and sulphur is so abundant and accessible, that the time is perhaps not far distant when it will be shipped to Europe. The crude deposit is stated to comprise 80 per cent. of sulphur.

Sawdust as a Fixer of Ammonia.—Sawdust is said to be one of the very best absorbents of liquid manure. Mixed with diluted sulphuric acid, it is one of the best materials for fixing the ammonia which is given off in stables. The following experiments have been put on record. A shallow basin, in which sawdust moistened with diluted sulphuric acid was spread, was hung up in a stable, and, in the course of three weeks, all the acid in the sawdust was neutralised by the ammonia in the air of the stable, and a considerable quantity of sulphate of ammonia was formed in this manner. For this reason, sawdust, mixed with sulphuric acid, is recommended as a means of keeping stables sweet and wholesome. This acid should be diluted with forty times its bulk of water before it is applied to the sawdust. Just enough should be applied to make the sawdust feel damp. On account of its porosity, sawdust retains the acid very perfectly, and presents a large surface for the absorption of the ammonia.

The Formation of Oil in Olives.—M. S. de Luca has made an important series of observations on this subject. His object was to ascertain at what stage of the growth the fatty matter began to form, and what matter or matters preceded and gave birth to the oil. He found that a very young olive had the density 1·008, and that from this it slowly increased until the density reached 1·097. From this point, as the oil was formed, the density diminished, and the author found a perfectly ripe olive to have the specific gravity 1·007. Perhaps the most important point determined by the author was the presence of mannite, which, he says, appears to be essential to the formation of the fatty matter. The human physiologist may perhaps take a note of this fact. A peculiar bitter principle was also found in the green olives, which the author could not isolate. Like the mannite, it is also to be found in the leaves, which, perhaps in virtue thereof, appear to possess decided febrifuge properties.

Cinnamates and Nitro-cinnamates.—M. E. Kopp has prepared and described many of these. The general properties of the cinnamates he describes as follows:—Those with an alkaline base are soluble in water. The alkaline-earthy salts are but slightly soluble in the cold, but more so when heated. The earthy salts are insoluble, and are partially decomposed by boiling water. The metallic salts are almost insoluble even in boiling water, but are in general dissolved on the addition of a little acetic acid. Nitro-cinnamic, though a weak acid, forms neutral salts, and decomposes alkaline carbonates. The alkaline salts are very soluble, the others are but slightly so, or are altogether insoluble. They all deflagrate when quickly heated. Cinnamene, $C_{16} H_8$, is not only isomeric but completely identical with styrol. When pure it will change spontaneously into metacinnamene perfectly solid, transparent, and having all the properties, chemical and optical, of metastyrol.

Separation of Natural and Artificial Camphor.—In an alcoholic solution of natural camphor ammonia gives but a slight precipitate which is re-dissolved on shaking the mixture. A similar solution of artificial camphor, under the like treatment, gives a flocculent precipitate which remains undissolved.

APPLICATIONS FOR LETTERS PATENT.

Dated November 23, 1861.

2941. S. Sansum, Birmingham—Penholders.
2942. M. A. F. Mennons, Paris—Multiplication of motive power.
2943. C. H. J. W. M. Liebmann, Huddersfield—Textile and felted fabrics.
2944. J. Weems, Johnstone—Metallic tubes, and coating or plating metals.
2945. J. H. Johnson, 47, Lincoln's-inn-fields—Toothed wheels, and apparatus used in their manufacture.
2946. R. A. Brooman, 166, Fleet-street—Improved cup or vessel for administering liquids.
2947. J. Pitkin, Clerkenwell—Aneroid barometers.
2948. W. Bray, Deptford—Improved locomotive apparatus particularly adapted for agricultural purposes.
2949. E. A. Rouviere, Paris—Improved pump.
2950. F. De Wyldé, 10, Great College-street, Camden-town—Paper-making machinery.
2951. V. Pendred, jun., Kilkenny—Surface condensers.

Dated November 25, 1861.

2952. J. B. Hulard and L. G. Poupel, Paris—Hardening stones and plaster of Paris, and making them impervious to water.
2953. J. Macintosh, Regent's-park—Obtaining and applying motive power, and apparatus connected therewith.
2954. G. Lowry, Salford—Machinery for carding and hackling flax, tow, and other fibrous substances.
2955. J. Ronald, Liverpool—Machinery used for spinning hemp, flax, manilla, wool, and like fibrous material, and for the manufacture of topped-up, formed, or laid thread, twine, cord, line, cable, and other cordage.
2956. J. Goudie, Hartlepool—Reefing and stowing the sails of vessels.
2957. W. Burgess, Newgate-street—Reaping and mowing machines.
2958. J. Willcox, Ludgate-hill—Sewing machines and apparatus connected therewith.
2959. J. H. Johnson, 47, Lincoln's-inn-fields—Machinery for preparing oval picture frames.
2960. J. H. Johnson, 47, Lincoln's-inn-fields—Machinery for shelling and cleaning rice and other grain.
2961. A. V. Newton, 66, Chancery-lane—Removing and preventing the formation of calcareous and saline deposits in steam boilers.
2962. J. Halford, Birmingham—Collecting and utilizing smoke, gases, and such like products of combustion, rendering the same available for heating steam boilers and other purposes where heat is required, which improvements are also applicable to the desulphurization of coal in making coke.
2963. G. Clarke, Camberwell-lane—Fire-escape.
2964. P. Cowan, Barnes—Utilizing the waste heat of furnaces used in reburning animal charcoal.

Dated November 26, 1861.

2965. A. W. Willis, 28, Great Russell-street, Bloomsbury—Pencil cases or holders.
2966. C. G. Braxton, Portsea—Propelling and steering vessels.
2967. J. Brown, Stratford—Fire bars and furnaces.
2968. I. Davies, Wavertree, Liverpool—Construction of roofs for dwelling houses, horticultural erections, and other buildings.

2969. R. Harcourt, Birmingham — Fastening knobs to doors, drawers, and other articles, and connecting knobs to spindles.
2970. W. Sellers, Keighley, Yorkshire — Apparatus for sewing.
2971. C. Stevens, 31, Charing Cross—Penholders.
2972. C. Stevens, 31, Charing Cross—An indelible anti-corrosive ink.
2973. G. Bottomley, Leeds—Machinery for cutting up linen, cotton, woollen, and other rags, fibrous waste, or vegetable substances, for various purposes in the industrial arts.
2974. D. Ker, Plymouth—Manufacture of soap.
2975. W. Firth and R. Ridley, Leeds—Machinery for working coal and other mines.
2976. J. H. Johnson, 47, Lincoln's-inn-fields—Apparatus for supporting the womb in cases of prolapsus uteri.
2977. G. E. Donisthorpe, W. Firth, and R. Ridley, Leeds—Machinery for working coal and other mines.
2978. G. L. Purchase, 23, Bedford-row, Holborn—Apparatus applicable to and improvements in rifled and other muskets, and ordnance and other fire-arms.

Dated November 27, 1861.

2979. J. Standfield, Stratford—Apparatus for regulating and indicating the speed of steam engines and other machinery.
2980. F. A. Calvert, Manchester—Machinery for burring, carding, and combing wool, and other fibrous substances.
2981. F. F. Dumarchey, Paris—Machine to crush and pound all material peculiar to macadam and ore in general.
2982. G. Rydill, Dewsbury, Yorkshire—Steam cornace or other boiler with smoke consumer and condenser, being also applicable for ventilation.
2983. W. Leck, Glasgow—Weaving, printing, and otherwise treating certain ornamental fabrics.
2984. J. Cook, Glasgow—Pendent lamps.
2985. A. Whibley and T. Lumley, Old Brompton—Ventilators.
2986. H. Brambach, Cologne — Gas for illuminating purposes.
2887. A. Barclay, Kilmarnock—Machinery for boring and winding purposes.
2988. H. Mearing, 18, Great Randolph-street, Camden Town—Lucifer match and prepared paper for igniting the same.
2989. A. V. Newton, 66, Chancery-lane—Mowing and reaping machinery.
2990. W. Clark, 53, Chancery-lane—Clasps or fastenings of purses, bags, portfolios, tobacco pouches, and other like articles.
2991. W. Clark, 53, Chancery-lane—Construction of parts of electric telegraph bell apparatus, and in apparatus used in making the same.
2992. J. H. Soller, St. John-street-road—Cases for holding and supplying caps to the nipples of rifles and other fire-arms.
2993. M. Ohren, Sydenham—Manufacture of gas and the apparatus connected therewith.
2994. M. Henry, 84, Fleet-street—Soap and the preparation of materials for the purpose.
2995. W. Rowan, Belfast — Machines for heckling and scutching flax and other vegetable fibres.
2996. S. Amphlet, Birmingham—Ornamenting surfaces.

Dated November 28, 1861.

2997. H. Wilde, Manchester—Magneto-electric telegraphs, and apparatus connected therewith.
2998. W. Cooke, 26, Spring-gardens, and F. Squire, Fleet-street—Construction of paddle-wheels for vessels propelled by steam or other motive power.
2999. C. Stevens, 31, Charing Cross—Furnaces for working iron ore.
3000. J. M. Rowan, Glasgow—Railway wheels, and apparatus to be used therein.
3001. S. A. Carpenter, Birmingham—Attaching name-plates or labels to umbrellas, parasols, walking sticks and whips.
3002. P. Spence, Newton Heath—Treatment of ores for the manufacture of sulphuric acid, and apparatus connected therewith, which apparatus is also applicable to the treatment of ores for separating metals therefrom.
3003. F. F. Weiss, Strand—Fastening for boxes and cases.
3004. W. A. Kanig, Brompton-road—Stoves or open fireplaces for utilizing more of the heat therefrom than heretofore, also for economising fuel and igniting the same.
3005. J. D'A. De Labaume, 9, Dorset-terrace, Clapham-road —Machinery for cooling and freezing water and other fluids.
3006. B. Pitt, 3A, Great Carter-lane, and J. J. Shedlock, Kensington—Cocks or valves for the passage of fluids.

Dated November 29, 1881.

3007. E. Funnell, Brighton—Self-acting indicator signal for railways.
3008. L. H. C. J. Carle, Holborn—Apparatus for indicating and registering the score for billiards and other games.
3009. T. Ellis, Swindon—Rails for permanent ways.
3010. A. B. Childs, 481, New Oxford-street—Wringing machines.
3011. S. Tonks and J. Brookes, West Bromwich—Steam boiler furnaces and in setting certain kinds of steam boilers.
3012. R. C. Perry, Manchester—Infant's feeding bottle.
3013. P. Tagliacozzo, 41, Saint Mary-at-Hill—Lamps and utensils thereof.
3014. R. A. Brooman, 166, Fleet-street—Safety buffer or apparatus to be used in railway trains to prevent accident from collisions.
3015. E. Tyer, 15, Old Jewry Chambers—Electric telegraphs.
3016. R. Cooke and G. Spencer, Hathersage, Derbyshire —Umbrellas and parasols.

Dated November 30, 1861.

3017. W. Cooke, 26, Spring Gardens — Wind guard for curing smokey chimneys.
3018. J. W. Gibson, Dublin—Improvements in ordnance, applicable also to small arms.
3019. J. Cooper, Ipswich, and C. Garrood, Penge—Cultivators, horse shoes, horse rakes, and harrows.
3020. E. Price, Cheapside—Collars for gentlemen's ladies', and children's wear.

Dated December 2, 1861.

3021. A. Schultz, Paris—Manufacture of certain colours for printing and dyeing fabrics.
3022. J. Wakenell, Hitchen—Construction of invalid bedsteads, convertible in other articles of furniture for the use of invalids.
2023. W. P. Bain, Blackwall—Protecting ships' bottoms from fouling.
3024. G. Ralston, 21, Tokenhouse yard—Preparing and applying a certain material on the hulls of iron or wooden ships or on the surfaces of materials for building the same, also for preventing oxidation and tubercles in iron water pipes.

December 3, 1861.

3025. T. W. G. Treeby, Westbourne-square.—Machines for boring holes in rocks and other hard substanees.
3026. R. A. Rust, 34, Great Marlborough-street, Westminster.
2027. A. M. A. Pichery and P. L. Danais.—Hemetically stoppering or convering earthen, stone, glass, or any other matter, jars and pots of all sizes and shapes.
3028. J. H. Glew, Fitzroy-square.—Machinery for sewing or stitching.
3029. J. Burrows, Wigan, and J. Dougan, Haigh.—Winding or driving drums or pulleys.
3030. J. Leach, East-street, Walworth.—Preparing matters to be used in the manufacture of candles.
3031. G. T. Bousfield, Brixton.—Stopper for bottles, decanters, jars, and similar articles.
3032. J. L. Field, Lambeth.—Mould candles.
3033. W. Duchemin, Prince Edward's Island.—Blocks for hoisting.
3034. W. E. Newton, 66, Chancery-lane.—Artificial teeth.
3035. W. E. Gedge, 11, Wellington-street, Strand.—Nose bags and similar articles, and apparatus connected with such manufarture.

Dated December 4, 1861.

3036. J. Hemingway, Robert Town.—Manufacture and ornamentation of texile fabrics.
3037. T. Stead, and W. Higham, Ashton-under-Lyne—Machinery for spinning cotton or other fibrous materials.
3038. C. Crabtree, Bingley—Paper tubes, and the means or machinery for making or manufacturing the same.
3039. J. E. Boyd, Lewisham—Scythes, scythe handles, and apparatus for connecting the same.
3040. H. G. Hacker, Woodford Bridge—Machinery for the manufacture of chenille and other circular pile fabrics.
3041. W. E. Newton, 66, Chancery-lane—Pumps.
3042. R. Kennedy, and J. Armstrong, Lisburn—Driving gear.
3043. W. H. Balmain, Saint Helen's—Potash and salts of potash.
3044. R. A. Brooman, Fleet-street—Albums or books for containing and showing photographic and other pictures, and slides forthe same.
3045. A. Pulian, and W. Lake, both of New Cross—Traction and other engines, and wheels for traction engines and other carriages, and giving motion to ploughs and other agricultural machines.
2046. C. S. H. Hartog, Norfolk-street, Strand—Preparation and treatment of vegetable fibres, the better to adapt them for combining, working up, and dyeing with different fibres, such as silk, wool, cotton, and others, and apparatus used in such treatment or preparation.

Dated December 5, 1861.

3047. A. T. Carr, Carlisle-street, Soho—Material for the shoes on horses' feet for the purpose of preventing their feet from slipping.
3048. J. Knowelden, Southwark—Pumps.
3049. G. W. Robertson, Cannon-street—Machinery for cleaning rice and other grain.
3050. J. Wilson, Glasgow—Frames used for displaying trade show cards, pictures. or other similar devices.
3051. W. Dicks, Floore—Pumps.
3052. J. Cochrane, Harburn—Wet gas meters.
3053. W. Bushby, Newton-le-Willows—Ploughs.
3054. C. Davis, Bancroft-place, Mile End—Composition for coating metal and wood to preserve them from decay, applicable as a substitute for copper and other sheating or other compositions now in use for coating ships bottoms.
3055. M. Henry, 84, Fleet-street—Printing texile fabrics, and constructing apparatus and producing surfaces for that purpose, the invention being also applicable to the mode of, and surfaces and apparatus for producing devices on paper hangings and other materials.

Dated December 6, 1861.

3056. E. D. Seeley, T. F. Wells, and G. A. Phillips—Capping percussion fire-arms.
3057. A. W. R. and W. Woodward, Manchester—Compound steam engines.
3058. J. and W. H. Bailey, Salford—Apparatus for indicating the pressure of steam and gases, the amount of vacuum, the flow of fluids, the weight of materials, and the speed of bodies either revolving or traversing, and also the employment of aluminum or its alloys in the manufacture of the same.
3059. C. Craddock, Kensington—System of cutting out ladies' dresses.
3060. J. D. Napier, Glasgow—Brakes.
3061. E. Collier, Aldershot—Coverings for the feet and legs.
3062. F. Vetterlin, Scarborough-street — Breach-loading ordnance, and the projectiles to be used therewith and with small arms.
3063. W. Smith, Kettering—Horse shoes.
3064. J. Howard, Bedford—Haymaking machines.
3065. H. G. Schramm, Hamburg—Rotary engines and pumps.
3066. J. J. Russell, and B. L. Brown, Wednesbury—Apparatus used in the manufacture of paper tubes.

Dated December 7, 1861.

3067. T. Lawes, 65, City-road—Quilts and coverlets.
3068. G. Clark, 30, Craven-street, Strand—Application, and manufacture of iron or steel as armour for ships or batteries.
3069. R. Jolley, 47, St. John-street, Smithfield—Apparatus for heating, cooling, or drying, infusing, extracting, or absorbing vapours or gases, for manufacturing, medical, or domestic purposes, and for preserving liquids, and solids, alimentary or otherwise.
3070. G. T. Bladon, Camberwell—Chimney tops for the prevention of down draughts in chimnies.
3071. D. May, Wood-street—Securing scarfs and simlar articles to the neck.
3072. W. N. Hutchinson, Devonport—Projectiles and ordnance, and apparatus to be used therewith.
3073. H. W. Bristow, Jermyn-street—Candles.
3074. T. Fearn, and T. Cox, jun., Birmingham—Application of certain electro deposits to the coating or finishing of the stretchers, ribs, and other metal portions of umbrellas and parasols.
3075. T. Mellodew, Oldham, W. Kesselmeyer, Manchester, and J. M. Worrall, Salford—Dyeing and printing certain descriptions of woven fabrics.
3076. B. W. Gerland, Newton-le-Willows — Sulphate of copper and other salts of the same metal.

Dated December 9, 1861.

3077. R. Fenner, 7, Red Lion Court, Fleet-street—Machinery for cementing the points of envelopes.
3078. C. F. Varley, 4, Fortess-terrace, Kentish Town—Electric telegraph. Complete Specification.
3079. M. A. F. Mennons, Paris—Natatory apparatus.
3080. M. A. F. Mennons, Paris—Application of microscropic photography.
3081. M. A. F. Mennons, Paris—Production of relief designs on metallic surfaces for general printing, gaufering, and embossing purposes.
3082. J. Fordred, Brighton—Treating linseed oil.
3083. R. A. Brooman, 166, Fleet-street—Treating atmospheric air and other elastic fluids for motive power purposes, and engines and apparatuses to be employed therewith.
3084 R. A. Brooman, 166, Fleet-street—Black lead pencils.
2085. S. W. Silver, Bishopsgate-street, and H. Pringle, King's-road, Chelsea—Shoes for horses and other quadrupeds.
3086. W. Mason, Poplar—Applying armour or thick plating to ships and other structures.
3087. W. Clark, 53. Chancery-lane—Gloves.
3088. S. Newton, 17, Nutford-place, Edgeware-road—Steering and stopping vessels.

Dated December 10, 1861.

3089. G. Tear, Liverpool—Drying of wet or damaged cotton or wool or other similar fibrous material.
3090. H. Alexander, Glasgow — Turning apparatus for making gas burners.
3091. H. Spencer, Rochdale—Apparatus for spinning and doubling cotton and other fibrous substances.
3092. W. F. Stanley, 3, Great Turnstile, Holborn—The use of aluminium for the construction of mathematical instruments.
3093. J. A. J. Redier, Paris—Pocket watches.
3094. V. L. Daguzan, Paris—Paving.
3095. G. C. Lock, Liverpool—Cinder sifters.
3096. T. Higgins, Bow—Machinery for filling dipping clamps with tapers, match stems, and splints.
3097. W. E. Newton, 66, Chancery-lane—Breech-loading cannon.
3098. W. E. Newton, 66, Chancery-lane—Knapsacks.
3099. D. Vogl, Basinghall-street—Garments for gentlemen's and ladies' wear.
3100. J. W. Agnew, London, Canada West—Electro-voltaic pocket battery.

Dated December 11, 1861.

3101. M. A. F. Mennons, Paris—Jack machinery for moving heavy bodies. (Complete specification).

3102 H. Tanner and W. Proctor, Bristol—Method of applying manure to growing crops.
3103. W. Clark, 53, Chancery-lane—Stoppering bottles and other vessels.
3104. W. C. S. Percy, Manchester—Machinery for making bricks, tiles, pipes, and other articles formed of plastic materials.
3105. J. Schloss, Cannon-street—Forming the leaves of albums and books for containing photographic portraits and views.
3106. R. A. Brooman, 166, Fleet-street—Treating teazles or thistles to be used in the teazing of cloths and stuffs and otherwise.
3107. R. A. Brooman, 166, Fleet-street—Decorating or printing upon china, porcelain, earthern and other like wares.
3108. W. H. Tooth, Rhodeswell-road, and W. Yates the younger, Parliament street—Iron and steel, and the machinery and furnaces used therein, and for the production of gas to be employed in such manufacture.
3109. J. Potter, Leeds—Jointing or connecting telegraph wires, which is also applicable to jointing or connecting signal wires, fencing wires, and other wires or rods.
3110. J. Leming, Bradford—Looms for weaving.

Dated December 12, 1861.

3111. R. Searle, Woodford-wells, Essex—Treatment, preparation, and combination of metals used for sheathing ships and marine erections, also for roofing buildings and and other purposes.
3112. M. A. F. Mennons, Furnival's Inn—Defecating and purifying cane and other saccharine juices.
3113. W. Lightfoot, Harwell, Berkshire—Improved bridle.
3114. W. W. Godfrey, Clerkenwell—Shield protector for Albert guards.
3115. W. F. Wiley, Birmingham—Pencil cases and holders for crayons and other solid writing or marking materials, which improvement or improvements may also be applied to crotchet needle holders.
3116. R. Mushet, Coleford, Gloucestershire—Iron and puddled steel.
3117. W. S. Longridge, Alderwasley Iron Works, Derbyshire—Railway wheels and tyres.
3118. A. Tonnar, Eupen, Rhenish Prussia—Drying and cleansing of malt as well as any other species of grain and seed intended for brewing, distilling, and agricultural purposes.
3119. J. W. Scott, Worcester—Wads for fire-arms.
3120. J. D. Jobin, Clapham-road—Locomotive engines, parts of which improvements are also applicable to marine and stationary engines.
3121. H. Bailey, Cheapside—Improved button or stud.

Dated December 13, 1861.

3122. R. Ashworth, G. Shepherd, J. Cormack, and J. Dearden, Stacksteads.—Looms for weaving.
3123. S. B. Hewett, Fairfield-road, Bow.—Boilers or generators for steam engines and other uses.
3124. W. Bell, Leamington.—Cooking ranges.
3125. F. Brampton, Birmingham.—Middle joints of measuring rules.
3126. H. J. Olding, Smith-square, Westminster—Feeding steam boilers, also apparatus for supplying fluids for other purposes, and in apparatus for raising fluids.
3127. E. C. B. De Beaulieu, Avallon, France—Spirituous liquors, and apparatus employed therein.
3128. G. Bird, Glasgow—Lubricating grease.
3129. J. W. Friend, Southampton—Apparatus for registering the depth and flow of liquids, and the distances run by ships at sea.
3130. T. Walker, Birmingham—Indicating the speed of vessels, and for taking soundings.
3131. T. B. Gibson, Glasgow—Ornamental fabric.
3132. S. Padley, Swansea—Paddle-wheels.
3133. P. Quantin, Bouscat, France—Manufacturing moulded earthen or stoneware cross sleepers for superseding wooden ones in the construction of railways.
3134. T. Cabourg, Paris—Screwing leather for the manufacture of shoes and for other purposes.
3135. A. V. Newton, 66, Chancery-lane—Fire-escape.
3136. J. Hetherington, Manchester—T. Webb, Uttoxeter, and James Craig, Tutbury—Machinery for spinning and doubling cotton and other fibrous materials.
3137. H. Appleby, Plumstead-common, and H. Harrison, Northampton—Machinery for boring wood and other materials used in the manufacture of brooms and brushes.
3138. T. K. Adkins, Wallingford, and J. Bonthron, 106, Regent-street—Manufacture of starch and apparatas employed therein.
3139. J. Kelly, Brook Lodge, Roscommon—Treatment of milk for the manufacture of butter and apparatus for the same.
3140. R. A. Brooman, 166, Fleet-street—Apparatus for the production and application of motive-power.
3141. R. A. Brooman, 166, Fleet-street—Blowers or apparatuses for superheating steam and other gases, and for projecting them combined with atmospheric air upon ignited combusttble matter.

Dated December 14, 1861.

3142. E. C. B. De Beaulieu, Avallon, France—Apparatus for extracting gold dust from anriferous sands.
3143. J. E. Duyck, West Farleigh—Expression of oil from cake and seeds, and apparatuses employed therein.
3144. F. Kohn, Waterloo-bridge—Copying writings, drawings, prints, and similar objects.
3145. C. McDougall and J. Crane, Manchester—Raising and supporting ladies' dresses.
3146. W. R. Rogers, Gray's Inn Road—Constructing dove-tail joints.
3147. W. D. Debenham, Kensington-Gardens-square—Plate holder for photographic purposes.
3148. W. Husband, Hayle—Water safety valve.
3149. J. H. Jonnson, 47, Lincoln's Inn Fields—Railway rolling stock.
3150. F. Cajoz, St. Servais, Belgium—Pyrites for the manufacture of iron.

Dated December 16, 1861.

3151. J. Willis, Newcastle-on-Tyne—Preparation of materials applicable to the manufacture of paper.
3152. G. P. Vallas, Camden-town—Baths with the object of rendering them available for use as trunks or boxes.
3153. G. Davies, Lincoln's Inn—Textile materials.
3154. W. Bartram and W. S. Harwood, Sheffield—Apparatus for filling and ramming cartridges for breech-loading and other fire-arms.
3155. D. Chalmers, Glasgow—Looms for weaving, and the manufacture of cloth therefrom.
3156. J. Aitken, Edinburgh—Supplying water to water-wheels.
3157. W. G. Laws, Tynemouth—Railway point signals.
3158. C. Baumann, Altdorf, Wurtember—Buttons.

Dated December 17, 1861.

3159. W. H. Tucker, 181, Fleet-street—Locks.
3160. J. W. Chalfont, Islington, and D. Keys, Craven-street, Strand—Winding up fusee watches and pocket chronometers, and setting the hands without key.
3161. J. B. Bunney and T. Wright, Birmingham—Ornamenting metallic and non-metallic bedsteads and other articles made principally of metallic rods or tubes.
3162. R. Shaw, Marple, Cheshire—Carding engines.
3163. J. Dale, Manchester—Glue or size.
3164. A. V. Newton, 66, Chancery-lane—Hoisting apparatus.
3165. J. Platt and W. Richardson, Oldham—"Gins" for cleaning cotton from seeds.

Dated December 18, 1861.

3166. R. Scott, 29, Great Portland-street—Rifling or grooving the barrels of fire-arms and ordnance.
3167. S. Sheppard, Birmingham—Stop cock.
3168. J. Perrin, Hyde, Cheshire—Equilibrium valve.
3169. M. Cartwright, Carlisle—Beds or palates for the reception of artificial teeth.
3170. W. Dicey, Waltham Abbey—Submarine electric telegraphic cables.
3171. A. Petersen, Schleswig—Drainage and irrigation for meadow and other land.
3172. M. Hanff, Tottenham-street—Boxes and cases.
3173. J. Piddington, 52, Gracechurch-street—Condensing apparatus for steam engines.
3174. J. Thiebaut, Mile End—Ornamentation of textile fabrics.
3175. C. E. Symonds, 56, Stone's End—Treatment and application to various useful purposes of certain organic compounds.
3176. E. Pace, Queen-street, London—Lath for Venetian blinds.
3177. J. M. H. A. Taurines, Paris—Constructing balances, weigh bridges, and other weighing machines.
3178. B. Bannehr, Exeter—Apparatus for desiccating grain, seeds, and other articles.
3179. C. Pontifex, Islington—Refrigerators for cooling worts or other liquors.

Dated December 19, 1861.

3180. W. Betts, Wharf-road, City-road—Coverings for the ends of cigars.
3181. T. Bourne, New York, U.S.—Cotton gins.
3182. W. Tate, Horsley Hill, Durham—Armour, and in making and applying the same for protecting wood and iron ships of war and batteries.
3183. E. Stott, Ashton-under-Lyne—Apparatus used for collecting and removing the waste and dirt which occurs in the process of spinning cotton and other fibrous materials.
3184. J. H. G. Wells, Binfield-road, Stockwell—Pumping elastic fluids.
3185. A. Treuille and F. X. Traxler, Paris—Safety paper intended to prevent any forgery and fabrication of shares, bank notes, checks, bills of exchange, stamped paper, postage stamps, &c.

Dated December 20, 1861.

3186. W. Makin, Atterliffe—Cast steel mill chisels, and other taper tools and files.
3187. J. Standfield, Aylsford, and J. Standfield, Stratford,—Machinery for giving motion to ships and machinery, and for raising water.
3188. J. Smith, and J. B. Higgs, Coven—Thrashing machines and mills for grinding, and raising or moving grain in granaries and other places.
3189. C. E. Wilson, Falcon-square—Collars for gentlemen's, ladies', and children's wear.
3190. O. C. Evans, Whitton, Twickenham—Sewing machines. (Complete specification).
3191. J. Westwood, Poplar—Hydraulic presses.
3192. G. Niay, Paris—Utilisin bags, wrappers, or other similar articles made of paper or other materials, and in any form.
3193. G. Walkland, Saint-Pierre-les-Calais, France—Machines for winding lace or other similar fabrics or tissues on cards or other materials.
3194. W. Tipple, Gravesend—Paddle wheels for the propulsion of ships and other navigable vessels.
3195. V. D'Almeida, Marylebone—Obtaining colouring matter applicable for dyeing skins, silk, wool, and other fibrous materials.
3196. W. Clark, 53, Chancery-lane—Apparatus for the manufacture of matches.
3197. J. Redfern, Henley—Apparatus for raising the temperature of air in order to warm churches, conservatories, houses, and other buildings or places. (Complete specification).
3198. R. A. Brooman, 166, Fleet-street—Preparing silk fabrics to be employed in the manufacture of hats, caps, and bonnets.
3199. E. E. Perean, Moorgate-street—Composition for cleaning and revivifying woollen cloths and other fabrics, and the colours thereof.
3200. R. Wailes, Brighton—Apparatus for cleaning windows and glasses.
3201. T. Green, W. Green, and R. Mathers, Leeds—Lawn mowing, rolling, and collecting machines.
3202. G. T. Bousfield, Brixton—Machinery for attaching the soles of boots and shoes to the upper leathers.
3203. D. C. Le Souef, Twickenham—Cylinders used in printing calicoes and other textile fabrics.

Dated December 21, 1861.

3204. J. Wakefield, Birmingham—Sewing machines.
3205. T. M. R. Weare, and E. H. C. Moncton, Trafalgar-square—Submarine and other telegraphic communication, and apparatus connected therewith.
3206. W. Bennetts, Camborne, Cornwall—Mechanism required for and in the manufacture and composition of gunpowder.
3207. F. Grimaldi, Teramo. Italy—Rotatory steam boilers.
3208. M. W. Wiiliams, Handsworth, Staffordshire—Treating coal and other bituminous minerals and peat, in order to obtain solid and liquid hydro-carbons therefrom, and in apparatus to be used for that purpose.
3209. W. L. Allchin and W. Allchin, Northampton—Apparatus applicable to the superheating steam.
3210. W. C. Miles, Shoreditch—Lamp glasses.
3211. F. Selby, Surbiton—Boilers for the generation of steam in engines for applying steam for motive power purposes, and wheels and ways for steam carriages to run on.
3212. W. Kempe, Leeds—Scrays or tables applicable to gig mills, brushing mills, and other like machinery.
3213. C. Osman, Brixton—Manufacture and application of elastic or yielding surfacs for sitting, lying, or reclining upon.

Dated December 24th, 1861.

3214. J. H. Johnson, 47, Lincoln's Inn Fields—Apparatus for cleaning wheat and other grain.
3215. L. R. Boomer, 2, Thavies-inn, Holborn—Looms for the manufacture of sacks, knapsacks, mattress cases, and other goods.
3216. C. Smith, Bedford—Stays.
3217. J. Rosindell, Mile End—separating solid from liquid substances.
3219. E. Ede, St. John's Wood—Horse shoes.
3220. J. F. Harvey, 145, Strand—Umbrellas and parasols.
3221. A. V. Newton, Chancery-lane—Means for reducing the friction and wear of slide valves of steam engines.
3222. T. E. Vickes, Sheffield—Wheels of railway engines and carriages, and the machinery or apparatus to be used in making the same.
3223. E. B. Sampson, Stroud—Apparatus for drying wool and other fibres and substances.
3224. J. B. Wood, Broughton—Driving straps or bands, the backs of wire cards, and cop tubes.
3225. F. Laurent and J. Casthelaz, Paris—Manufacture of colouring matters.
3226. J. Cochrane, Dudley—Apparatus employed in sinking cylinders and open coffers for forming foundations under water.
3227. G. H. Birkbeck, 34, Southampton Buildings, Chancery-lane—Arrangement of traction and connecting apparatus for railway carriages and trains.
3228. T. Simmons, and T. Timms, Birmingham—Urns or vessels for holding and supplying hot water, tea, coffee, or other liquids separately or conjointly, as also the stands for the same.

Dated December 26, 1861.

3229. J. Jones, Liverpool—Manufacture of lead, tin, and other metals of a like nature, fusible at a low temperature into sheets of any thickness or length.
3230. T. Standing, Preston—Cinder sifters and ash receptacles applicable to domestic fire grates.
3231. L. J. Taulin, Paris—Wind musical instrument.
3232. J. Scholoss, Cannon-street—Envelopes for containing photographic portraits and pictures.
3233. N. A. Burnier, Lyons—Lace.
3234. J. Shepherd, Manchester—Apparatus for cleansing steam boilers.
3235. R. Needham, Dukenfield—Apparatus for cleansing steam boilers and lubricating the pistons of steam engines, and for an improved steam trap.
3236. H. Dawes, Manchester—Metal for crinoline.
3237. J. N. Palmer, Fenchurch-street—Cooking stoves and ships' ranges.

DENS[E…]	Actual Air Space through Fire Bars.	Description and Dimensions of Flues.	Tubes. Number.	Length.	Diameter.	Material.	Number and Dimensions of Chimneys.	Load on Safety Valve.	Consumption of Coal per hour.	REMARKS.
	Sq. ft.			Ft. in.	in.					
	108	Tubes...	2220	6 0	2½	Brass.	One 63′ 9″ high, 7′ 6″ dia.	16	Not recorded.	Speed not ascertained, in consequence of the bad state of the weather.
d Non...	40·5	"	878	6 0	2½	"	One 41′ 6″ high, 5′ 0″ dia.	11	"	Trial for special purposes, not for speed.
...	40·5	"	878	6 0	2½	"	" "	10	"	Ditto.
...	31·8	"	796	5 3	2⅜	"	One 39′ 4″ high, 4′ 6″ dia.	8	"	Trial interrupted; speed not to be relied upon.
...	31·8	"	796	5 3	2⅜	"	"	8	"	
...	67·2	"	1600	5 11	2½	"	One 47′ 0″ high, 7′ 2″ dia.	10	"	
...	15·7		348	5 8¼	2½	"	One 38′ 6″ high, 2′ 10″ dia.	12	"	Vessel purchased into the service; area of midship section and displacement not known.
...	16·2	"	363	5 6	2½	"	One 47′ 0″ high, 2′ 9″ dia.	12	"	
...	100·6	"	2808	6 6¾	2½	"	One 59′ 6″ high, 8′ 2″ dia.	20	"	
...	100·6	"	2808	6 6¾	2½	"	" "	20	"	
...	100·6	"	2808	6 6¾	2½	"	" "	20	"	
...	100·6	"	2808	6 6¾	2½	"	" "	20	"	
...	100·6	"	808	6 6¾	2½	"	" "	20	"	
...	100·6	"	08	6 6¾	2½	"	" "	20	"	
...	133·2	"	3[illegible]0	6 6	2½	"	Two 54′ 6″ high, 7′ 0″ dia.	20	"	Blades of screw bolted on with flanges.
...	6·1	"	3[illegible]	8 1	2	Iron.	One 20′ 4″ high, 2′ 2″ dia.	65	"	
....	6·1	"	32	8 1	2	"	" "	60	"	
....	6·1	"	327	8 1	2	"	" "	60	"	
....	6·1	"	327	8 1	2	"	" "	60	"	
....	45·8	"				"	Two 36′ 6″ high, 4′ 10″ dia.	20	"	
ion...	45·8	"	1116 [..]w Boilers	6	2½	Brass.	" "	20	"	
...	45·8	"					" "	20	"	
...	45·8	"					" "	20	"	
...	45·8	"	210 Hig[..] [..]oil'rs	6	2½	"	" "	20	"	Trial for special purposes, not for speed. Immersion of screw a negative quantity.
...	45·8	"					" "	20	"	
...	100·6	"	2808	6 6¾		"	One 76′ 6″ high, 8′ 4″ dia.	20	"	
...	100·6	"	2808	6 6¾		"	" "	20	"	
...	174·8	"	3520	6 8½	2½	"	Two 55′ 0″ high, 6′ 8″ dia.	22	"	
...	8·6	"	273	6 8	2	[Ir]on.	One 21′ 0″ high, 1′ 7″ dia.	60	"	Immersion of screw a negative quantity.
....	8·6	"	273	6 8	2		" "	60	"	
....	8·6	"	273	6 8	2		" "	60	"	
....	8·6	"	273	6 8	2	"	" "	55	"	
....	8·6	"	273	6 8	2	"	" "	60	"	
....	8·6	"	273	6 8	2	"	" "	60	"	
....	8·6	"	273	6 8	2	"	" "	60	"	
....	138·2	"	278·4	6 6	2½	Brass.	56′ 0″ high, 7′ 8″ dia.	20	"	
non..	138·2	"	278·4	6 6	2½	"	" "	20	"	
, ..	138·2	"	278·4	6 6	2½	"	" "	20	"	
, ..	138·2	"	278·4	6 6	2½	"	" "	20	"	
, ..	138·2	"	278·4	6 6	2½	"	"	20	"	
, ..							"	20	"	
	138·2	"	278·4	6 6	2½	"	"	20	"	
" ..	138·2	"	278·4	6 6	2½	"	"	20	"	
" ..	138·2	"	278·4	6 6	2½	"	One 61′ 0″ [..]gh, 7′ 8″ dia.	[..]	"	

BRITISH ASSOCIATION—COMMITTEE ON STEAMSHIP PERFORMANCE.

TABLE 1.—RETURN OF PERFORMANCE OF HER MAJESTY'S VESSELS, FURNISHED BY THE ADMIRALTY.

Name of Ship	Particulars of Trial	Actual Measurements of Ship	Propellers: If a Screw	Propellers: If a Paddle	Engines	Boilers	Remarks
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Vessel purchased into the service; area of midship section and displacement not known.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Blades of screw bolted on with flanges.

TABLE 5.—RETURN SHOWING THE RESULTS OF PERFORMANCE OF EIGHTEEN VESSELS IN THE MERCHANT SERVICE UNDER VARIOUS CONDITIONS.

Name of Ship	Particulars of Trial	Actual Measurements of Ship	Propellers: If a Screw	Propellers: If a Paddle	Engines	Boilers	Remarks
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

27·83 | 19·83 | 21·39 | 20·19 | 21·33 | 27·44 | 26·20 | 48·88 | 42·22 | 21·93 | 25·30 | 21·89 | 25·77 | 47·90 | 45·19 | 19·23 | 20·05 | 26·18 | 50·50 | 49·20 | 20·58 | 20·23 | 20·72 | 20·05 | 19·30 | 67·69 | 61·92 | 28·95 | 29·81 | 23·86 | 48·0

(CIRCULAR REFER...

BRITISH ASSOCIA...

COMMITTEE ON STEAMSHIP PER...

19, SALISBURY ...

Slip of Screw ....

BOILERS :—

No. of Furnaces at Work..

Square Feet of Grate Surface at Work ....

Square Feet of Heating Surface at Work..

Weight to which Safety Valve is loaded per Square Inch ....

Pressure of Steam per Square Inch in Steam Chest...... ....

Density of Water ....

Consumption of Coal per hour.. .....

Description of Coal during period ....

Indicated Horse-power, *with Diagrams* ....

Evaporation of Water per hour ....

DRAFT OF WATER :—

On Leaving Port—Forward.................. ....

Ditto ditto Aft ....

On Arriving in Port—Forward ....

Ditto ditto Aft ....

REMARKS ....

Office, 19, Salisbury Street, Strand,
London, W.C.

Signature.

*Date.*____

Evaporation of Water during ...	Distance of Engine from Screw Propeller.	Temperature of Sea Water.	Press. of steam at same inst. in boiler & before throttle valve by gauges.	Vacuum in Con-...	Number and Dimensions of Chimneys.	Load on Safety Valve.	REMARKS.
lbs.	ft. in.		lbs.	...s.			
2...	102 0	69	....	...	One 6′ 9″ dia., 53′ high.	20	Welsh Coals.
2...	102 0	....	....	...	" "	....	
	102 0	....	....	...	" "	....	
23	86 6	60	....		One 5′ 8″ dia., 53′ 8″ high. Two 4′ 10″ dia., 36′ 6″ high.	20 / 20	Nova Scotia (very bad).
....	65 0	50	....		" "	20	Welsh (good).
....	65 0	62	....		" "	20	Welsh (good).
48·0	65 0	63	....		One 7′ 2″ dia., 56′ 8″ high	21·9	

THE ARTIZAN.

No. 230.—Vol. 20.—FEBRUARY 1, 1862.

REPORT OF THE COMMITTEE ON STEAMSHIP PERFORMANCE.

In The Artizan for November last, we published the report of the Committee, but were unable to give the tables referred to therein.

Being now in a position to publish the whole of the tabulated matter in a large folding sheet, printed on both sides, we avail ourselves of this opportunity of completing the very valuable series of "Returns" collected by the committee during the year 1860-61.

Professor Rankine has called attention to some errors in Table No. 5: the corrections for these will be found in the "Notices to Correspondents."

MINERAL OILS FOR ILLUMINATION.

The introduction of the combustible liquids obtained by the destructive distillation of certain varieties of coal, or by the distillation of petroleum, of different kinds, into general use, as a source of artificial light, forms an era in the history of the manufacturing industry of this country; and it must prove both interesting and instructive to trace briefly the progress of a branch of manufacture which has reached, in the course of a few years, such an immense development, and which has been moreover the means of modifying in a very important degree the old system of domestic lighting.

Within ten years this branch of trade has sprung into existence, and it has at the present time acquired a magnitude which might appear incredible to those unacquainted with the subject, but of which some idea may be obtained from the statement given in evidence in a recent trial, that no less than 350,000 of the lamps proper for the burning of these fluids were manufactured by one firm in the course of the previous year.

In 1850this manufacture received its first impulse on an extended scale, in a patent granted to Mr. James Young, for distilling in a particular manner the mineral known as Boghead coal. Working under this patent, Mr. Young became the originator of a great business, and from that time to the present there has been no cessation to the efforts which have been made, either towards the invention of new methods of manufacturing the material actually known, or to the discovery of new materials capable of yielding these peculiar oils. Since Mr. Young commenced distilling the Boghead coal, there have been introduced into commerce the petroleum from Rangoon, in Burmah, which although it had been well known from a remote period, had never been applied to any useful object; the brown coal or lignite of certain parts of Germany, and lastly a native liquid petroleum, found in Pennsylvania and other parts of the United States, and in Canada.

The leading characteristic of the oils obtained by distilling all these substances is the same, they are what are now known as paraffine oils; this means chemically something more than that they yield by distillation, paraffine and various oils holding paraffine in solution, as it were; it means that in all probability the whole series of oils produced are indentical in chemical composition with paraffine, no matter what their physical character. This is not only the case with the oils obtained from the Petroleums, but it is so likewise with those from Boghead coal, and coals of a similar class, provided the temperature during the distillation be kept as low as is compatible with the complete decomposition of the of the coal. Carefully distilled at a low heat, these coals yield a minimum quality of gas, and a maximum of oil, which contains paraffine and the paraffine oils, but scarcely a trace of the fluid long known as coal naphtha, consisting of benzole and the liquids resembling it in composition. If, on the other hand, the coals be distilled at a higher temperature, at a bright red heat for example, the paraffine oils will in part be substituted by benzole and liquids of that type, which differ in many important respects from the paraffine oils.

Native petroleums have been well known in different regions of the earth from very ancient times, but their origin is one of the most interesting of scientific speculations; the forms in which they exist are very various, and their peculiar characters, within certain limits, scarcely less so. There can be no question that they are produced by a kind of destructive distillation proceeding in masses of organic matter deposited in the earth's crust in remote ages. The kind of bitumen containing or yielding paraffine and its congeners, appears to be derived from vegetable sources, while that which, although it yields analagous oils, gives little or no paraffine, is probably derived from animal matter, which has likewise sustained, or is now undergoing, a natural distillation. In the Rangoon petroleum, and in some of the varieties lately discovered in America, the paraffine exists already formed, but in other paraffine yielding materials, the organic matter is rather paraffiniferous than really paraffine. Boghead coal and the Welsh cannel coals found near Mold, belong to the last class, as do certain kinds of wood; in all of these a destructive distillation must be resorted to to produce the desired substances; but with the former class the treatment may be looked upon as a sort of rectification or refining of that which natural operations have previously brought into existence. It has been looked upon as remarkable that although Reichenbach, the discoverer of paraffine, pointed out the properties of the substance and its uses with perfect distinctness, many years since, no practical application of it and its allied oils was made before the time of Mr. Young's experiments, and it is no less remarkable that a sort of prophetic aspiration of Liebig has been fulfilled in the utilization of these illuminative substances. In the familiar Letters on Chemistry of the last-named author, he remarks that it was a desideratum in the arts to discover a means of obtaining olefiant gas in the solid form, so that it could be burned after the manner of an ordinary candle. In paraffine and the paraffine oils, we have the complete fulfilment of this desire, for in them we have virtually solid and liquid olefiant gas. With respect to the non-application of Reichenbach's discovery, however, until within the last few years, there is, in fact, nothing very remarkable, it was a purely chemical discovery arising out of the original investigations of an ingenious and sagacious chemist, but the results were obtained upon materials too costly and too limited in quantity to give them any really commercial value. The true practicability of the thing lies in the subsequent discovery of materials unbounded in quantity, moderate in price, and susceptible of being easily manufactured; had the matter remained where it was left by its discoverer it never could have possessed any value in the arts, whereas, by its application to materials which have a commercial character, it has been brought into a position to receive the extended utilisation which it possesses at the present moment. It is, therefore, after all, not remarkable that the discovery should have lain for some years dormant, seeing that the materials to which it could be applied on the large scale had to be discovered. It is rather remarkable that in ten years such a number of new substances should have been brought into commerce, many from totally unexpected sources, applicable to the necessities of the case. This affords one more example of the fact that in commercial matters demand and supply ever prove the complement to each other. In a chemical sense, the combustible liquids obtained from the different sources already mentioned are very interesting and important, but in a commercial sense they are at least equally so. With the exception of gas, no illuminating material has been before produced at so cheap a rate, taking light for light, with respect to amount and quality; indeed, if a calculation be made upon the cost of the two, that is light from paraffine oil and light from gas, taking gas at 5*s.* per thousand, and the oil at 3*s.* per gallon, the cost of light from the latter will not exceed that from gas by more than 20 per cent. There is no other source of artificial light which approaches by any means so nearly to gas in point of economy.

With respect to the comparative safety of employing these oils in lamps, it might be remarked that, although the use of such eminently combustible materials demands precaution, the paraffine oils do not readily, if at all, form explosive compounds with air as benzole and its allies do. The genuine paraffine oils being free from oils of the benzole type, may, it appears, be employed in proper lamps without danger of explosion, and with little or no danger from fire when anything like the necessary caution is used.

BRITISH ASSOCIATION—COMMITTEE ON STEAMSHIP PERFORMANCE.

TABLE 11.—SHOWING THE RESULTS OF THE PERFORMANCE OF SIX OF HER MAJESTY'S VESSELS UNDER VARIOUS CIRCUMSTANCES.

[illegible]

TABLE 3.—PERFORMANCE OF H.M.S. "VICTOR EMANUEL" AT SEA.

[illegible]

TABLE 4.

RETURN OF SEVEN TRIALS ON THE MEASURED MILE IN STOKES BAY, OF H.M. SHIP "VICTOR EMANUEL."

Victor Emanuel.	Full Power of Boilers 2 Bladed Screw.	Full Power of Boilers Screw ditto.	Full Power of Boilers 4 Bladed Iron Screw, made at Portsmouth Yard.	Full Power of Boilers Screw ditto.	Half Power of Boilers Screw ditto.	Full Power of Boilers Screw 2 Bladed.	Half Power of Boilers Screw ditto.
Date of Trial	28 Nov. 1856.	30 Dec. 1856.	15 Jan. 1858.	16 Feb. 1858.	26 Feb. 1858.	9 Sept. 1858.	9 Sept. 1858.
Trial made in	Stokes Bay.	Stokes Bay.	Stokes Bay.	Stokes Bay.	Stokes Bay.	Stokes Bay.	Stokes Bay.
Horse Power by Admiralty Rule	600 Horses.	600 Horses.	600 Horses.	600 Horses.	600 Horses.	600 Horses.	600 Horses.
Maker's Name	...	...	Maudslay,	Sons &	Field.	...	...
Draught of Water (Forward)	17 ft. 2 in.	17 ft. 3 in.	17 ft. 6 in.	17 ft. 5 in.	17 ft. 2 in.	23 ft. 3 in.	23 ft. 3 in.
Ditto (Aft)	20 ft. 6 in.	20 ft. 11 in.	20 ft. 11 in.	21 ft. 0 in.	21 ft. 2 in.	25 ft. 0 in.	25 ft. 0 in.
Weight on Safety Valve per square inch	20 lbs.	20 lbs.	20 lbs.	20 lbs.	20 lbs.	20 lbs.	20 lbs.
Pressure of Steam in Boilers (per sq. in.) by Gauge	20 lbs.	18 to 20 lbs.	20 lbs.	20 lbs.	20 lbs.	20 to 21 lbs.	19 to 20 lbs.
Vacuum in Condensers (Forward)	23½	23	22	23½	23½	23	24
Ditto (Aft)	23½	23	23½	22	24	23	24
Number of Revolutions of Engines, Mean	55½	58	51	51	43·4	50·833	45·676
Mean Pressure on Cylinders per square inch	19·59 lbs.	19·63 lbs.	21·19 lbs.	22·555 lbs.	15·23 lbs.	22·12 lbs.	14·42 lbs.
Indicated Horse Power	2098·23	2122·6	2079·3	2210·15	1250·00	2127·4	1977·32
Speed of Ship, Knots	11·923	12·000	11·626	11·713	9·032	10·874	9·075
Weather, Force of	No. 3.	No. 3 to 4.	No. 2 to 3	No. 4 to 5.	No. 4.	No. 4.	No. 4.
Wind by Admiralty Standard	Starboard Beam.	Port Bow when down the course.	Direct ahead when down the course.	Ahead when up course.	On port bow when up course.	On port bow down course.	On port bow down course.
State of the Sea	...	...	Smooth.	Smooth.	Smooth.	...	...
Ship if Rigged, or otherwise	Not Rigged.	Not Rigged.	Not Rigged.	Not Rigged.	Not Rigged.	Rigged.	Rigged.
Weights on Board	Not Known.	Not Known.	Not Known.	Not Known.	Not Known.	Not Known.	Not Known.
PROPELLER.							
Description	2 Bladed.	2 Bladed.	4 Bladed Compound	4 Bladed, form of	4 Bladed. Screw.	2 Bladed.	2 Blades.
Diameter	18·2	18·2	18·2	18·2	18·2	18·2	18·2
Pitch	20·2	20·2	20·0	20·0	20·0	20·2	20·2
Length	3·1	3·1	3·1	3·1	3·1	3·1	3·1

Area of Midship Section at Mean Draft of Water of 19 ft. 2 in. = 784·25 square feet. Ditto at Draft of Water of 24 ft. 2in. = 1000·0 square feet.
Guns, 91. Length between Perpendiculars, 230 ft. 3 in. Tonnage, 3059. Breadth (Extreme), 55 ft. 4 in.

PLATE 10.

RÉSULTATS DE LA NAVIGATION DES PAQUEBOTS DES SERVICES MARITIMES DES MESSAGERIES IMPÉRIALES PENDANT L'ANNÉE 1859.

[illegible]

PLATE 11.

RÉSULTATS DE LA NAVIGATION DES PAQUEBOTS DES SERVICES MARITIMES DES MESSAGERIES IMPÉRIALES PENDANT L'ANNÉE 1860.

[illegible]

TABLE 6.

L. & N. W. R.

CHESTER AND HOLYHEAD RAILWAY—STEAMBOAT DEPARTMENT.

A Return of the Speed, and Consumption of Coal of the Express and Goods Boats, under regulated Conditions of Time, Pressure, and Expansion for the undermentioned period.

Vessel.	Date.	No. of Trips run.	Passages Longest.	Passages Shortest.	Passages Average.	Average Rate of Speed.	Actual Weight on Valves.	Average Pressure Worked at.	Proportion of Steam in Cylinder.	Coals Consumed Per Trip, including getting up Steam, and while lying at Holyhead.	Per Hour, including raising Steam, Banking Fires, &c.	Per Hour exclusive of raising Steam, Banking Fires, &c.	Remarks.
Express Boats.	1860.		h. m.	h. m.	h. m.		lbs.	lbs.		T. cwt. lb.	T. cwt. lb.	T. cwt. lb.	
Anglia	1st Jan. to 31st March	66	6 6	4 8	4 43	[illegible]	16	13	[illegible]	12 13 8	2 13 67	2 7 50	
"	1st April to 30th June	63	5 25	4 3	4 51	[illegible]	16	13	[illegible]	12 4 80	2 13 05	2 7 20	
"	1st July to 30th Sept.	29	6 15	4 17	5 6	[illegible]	15	12	[illegible]	12 16 23	2 10 5	2 4 40	
"	1st Oct. to 31st Dec.	66	6 20	4 20	4 45	[illegible]	16	19½	[illegible]	13 5 22	2 16 05	2 0 53	
Cambria	1st Jan. to 31st March	28	5 14	4 16	4 39	[illegible]	16	16	[illegible]	12 17 6	2 16 27	2 9 09	
"	1st July to 30th Sept.	1	6 45	From Liverpool		[illegible]	14	13	[illegible]	17 7 0	2 11 45	2 6 101	From Liverpool to Holyhead after lengthening.
Scotia	1st Jan. to 31st March	60	6 15	4 10	4 44	[illegible]	15	12½	[illegible]	14 9 102	3 1 54	2 12 42	
"	1st April to 30th June	79	5 40	4 8	4 30	[illegible]	15	12½	[illegible]	13 10 5	3 0 74	2 0 40	
"	1st July to 30th Sept.	48	6 6	4 16	4 38	[illegible]	15	13	[illegible]	13 15 46	2 19 49	2 12 50	
"	1st Oct. to 31st Dec.	33	6 55	4 18	4 40	[illegible]	15	10½	[illegible]	13 16 28	2 17 63	2 11 5	
Telegraph	1st April to 30th June	17	4 38	4 5	4 20	[illegible]	10	9	Nil	14 19 10	3 0 71	2 10 68	
"	1st July to 30th Sept.	79	5 33	4 10	4 20	[illegible]	10	9	Nil	13 11 91	3 0 70	2 13 54	
"	1st Oct. to 31st Dec.	60	5 36	4 16	4 44	[illegible]	10	9	Nil	14 3 71	2 19 100	2 13 45	
Goods Boats:													
Hibernia	1st Jan. to 31st March	56	8 45	5 43	6 34	[illegible]	15	8½	[illegible]	15 0 06	2 5 77	2 1 109	
"	1st April to 30th June	76	8 0	5 45	6 21	[illegible]	15	8	[illegible]	14 9 22	2 5 21	1 18 70	
"	1st July to 30th Sept.	78	8 22	5 33	6 34	[illegible]	15	7½	[illegible]	14 8 91	2 5 110	2 0 92	
"	1st Oct. to 31st Dec.	73	10 0	5 15	6 50	[illegible]	15	8½	[illegible]	15 4 40	2 3 101	1 19 4	
Cambria	1st Oct. to 31st Dec.	29	7 25	4 55	5 41	12·21	15	10	[illegible]	12 11 51	2 3 94	1 18 30	
Ocean	1st Jan. to 31st March	40	10 30	6 45	8 2	9·77	10	8½	Nil	11 9 81	1 8 09	1 4 101	
"	1st April to 30th June	4	8 45	8 50	6 57	10·0	10	8½	Nil	10 5 81	1 9 07	1 0 81	
Hercules	1st Jan. to 31st March	33	10 40	6 15	7 55	[illegible]	12	10½	Nil	9 6 74	1 3 78	1 1 30	
"	1st April to 30th June	23	8 00	6 0	7 2	[illegible]	12	11	Nil	8 17 00	1 5 27	1 2 41	
"	1st July to 30th Sept.	20	11 40	6 0	7 5	[illegible]	12	11	...	8 5 70	1 3 55	1 0 73	
"	1st Oct. to 31st Dec.	37	10 10	6 17	7 40	[illegible]	12	12½	Nil	8 14 28	1 2 32	0 19 108	
Sea Nymph	1st Jan. to 31st March	54	9 15	6 25	6 30	10·81	12	10½	1st & 2nd grade	11 15 58	1 15 45	1 13 16	
"	1st April to 30th June	78	8 50	5 30	6 30	10·81	12	10½	1 and 2 grade and full speed	10 10 53	1 13 13	1 9 84	
"	1st July to 30th Sept.	76	7 55	5 25	6 28	10·91	12	10½	1st & 2nd grade	11 4 72	1 14 103	1 11 16	
"	1st Oct. to 31st Dec.	40	10 20	5 36	6 50	11·46	12	10½	1st grade	12 5 14	1 15 90	1 12 40	

TABLE 7.—CHESTER AND HOLYHEAD—STEAMBOATS.

Consumption of Coal for the 12 Months ending December 31st, 1860.

Name of Vessel.	Three Months ending	Number of Trips.	Average Number of Tons each Trip.	Total for the 12 Months.	Total as shown by General Accounts, including Coal on board.
			T. cwt. lb.	T. cwt. lb.	T. cwt. lb.
Anglia	March 31	66	12 13 8	2790 7 57	2772 10 0
"	June 30	63	12 4 80		
"	September 30	29	12 16 23		
"	December 31	66	13 5 22		
Cambria	March 31	28	12 17 6	377 4 50	...
"	June 30	Nil	...		
"	September 30	1	17 7 0	377 4 50	400 7 0
Scotia	March 31	60	14 9 102	3165 18 43	3186 0 0
"	June 30	79	13 10 5		
"	September 30	48	13 15 46		
"	December 31	33	13 16 28		
Telegraph	March 31	Nil	...	...	...
"	June 30	17	14 19 10	2037 0 80	2063 1 0
"	September 30	79	13 11 91		
"	December 31	60	14 3 71		
Cambria	December 31	29	12 11 51	364 19 23	400 0 0
Hibernia	March 31	56	15 0 66	4176 14 80	4106 5 0
"	June 30	76	14 9 22		
"	September 30	78	14 8 91		
"	December 31	73	15 4 40		
Hercules	March 31	33	9 6 74	1049 16 70	1039 14 0
"	June 30	23	8 17 00		
"	September 30	20	8 5 70		
"	December 31	37	8 14 28		
Ocean	March 31	40	11 9 81	500 11 101	499 5 0
"	June 30	4	10 5 81		
Sea Nymph	March 31	54	11 15 58	3060 16 104	2913 10 0
"	June 30	78	10 10 53		
"	September 30	76	11 4 72		
"	December 31	40	12 5 14		
...	...	...	...	17,422 3 60	17,436 10 0

TABLE 8.—CITY OF DUBLIN STEAM PACKET COMPANY

A Return of the Average Time of Passage and Consumption of Coal of the Mail Steamers for Six Months ending June 30th, 1860.

Vessels.	Date.	Number of Trips.	Passages Longest.	Passages Shortest.	Passages Average.	Coal per Trip (T. / cwt. / lbs.)	Diameter of Cylinder.	Length of Stroke.	Nominal Horse Power.
			h. m.	h. m.	h. m. s.	T. cwt. lbs.	in.	ft. in.	
Prince Arthur	January 1st to March 31st	120	5 45	4 8	4 43 4	11 8 0	[illegible]	4 0	75
	[illegible]	120	5 11	4 15	4 36 0	11 6 5			
		240			4 [illegible] 7	11 5 11			
Llewellyn	January 1st to March 31st	94	6 20	4 10	4 43 0	15 9 60	69	6 0	350
"	April 1st to June 30th	120	6 17	4 19	4 42 4	14 14 37			
		214			4 43 7	14 15 37½			
Eblana	January 1st to March 31st	118	6 10	4 10	4 52 6	11 9 94	[illegible]	6 0	325
"	April 1st to June 30th	[illegible]	[illegible]	4 10	[illegible]	[illegible]			
		242			4 46 1	10 17 63			
St. Columba.	January 1st to 31st (did not carry the Mails after Jan.)	33	6 29	4 27	5 10 0	14 19 4	73	8 0	350

TABLE 9.—CITY OF DUBLIN STEAM PACKET COMPANY.

A Return of the Average Time of Passages and Consumption of Coal of the Mail Steamers for Three Months ending 30th September, 1860.

[illegible]

TABLE 12.

Return of the Average Passages of Mail Packets and Consumption of Coal for Six Months, ending 31st March, 1861.

Name of Vessel.	Number of Trips.	Average Time, including Fogs, &c.	Coal Consumed, including getting up Steam. Anthracite.	Bituminous.	Total.	Average per Trip.
		h. m. s.	Tons.	Tons.	Tons.	Tons. cwt.
Leinster	183	3 41 5	2437	3956	6393	34 13
Ulster	203	3 50 0	4244	2316	6560	32 6
Munster	148	3 53 0	2670	2718	5307	36 6
Connaught	192	3 42 0	4179	2124	6303	32 16

Note.—The *Ulster* and *Munster* encountered a larger proportion of severe weather and fogs than the *Leinster* and *Connaught*.

TABLE 13.

STEAMSHIP "LEINSTER."

On Trial from Holyhead to Kingstown, April 4th, 1861.

	Steam.	Barometer.	Revolutions.	Boiler Gauges. Fore.	Aft.
	lbs.	Inches.			
First Half-hour	26	26	24	27	26½
Second "	25	26½	23½	26½	26
Third "	24½	26½	23½	26	25½
Fourth "	24½	26	26½	26½	25½
Fifth "	25	26	23½	26	25½
Sixth "	25	26	23½	26	26
Seventh "	25	26½	24	26½	25½

No. of Revolutions as per Counter, 4937.
Length of Passage, 3 hours 28 minutes.
Total Consumption about 40 tons.

TABLE 14.

STEAMSHIP "ULSTER."

On Trial from Kingstown to Holyhead, April 5th, 1861.

	Steam.	Revolutions.	Counter.	Vacuum.
	lbs.	per min.		
At Starting	21	...	...	
First Half-hour	23½	23	700	13½. Steady.
Second "	22½	22½	1570	
Third "	23	23	2086	
Fourth "	[illegible]	[illegible]	2716	
Fifth "	23½	23	3398	
Sixth "	[illegible]	[illegible]	[illegible]	
To arrival	23	[illegible]	[illegible]	

Time of Passage, 3 hours 30 minutes.
Total Consumption about 36 [illegible]
No. of Revolutions as per Counter, [illegible]

BRITISH ASSOCIATION.

COMMITTEE ON STEAMSHIP PERFORMANCE.

[illegible]

British Association—Committee on Steamship Performance.

Return of H. M. Steamship [illegible]

[illegible]

Office, 10, Salisbury Street, Strand, London, W.C.

PRACTICAL PAPERS FOR PRACTICAL MEN.

NO VII.—ON BRIDGE PLATFORMS.

Having, in the foregoing papers, disposed of the questions relating to the construction of main girders, the next step will consist in giving an account of the method of constructing the roadways or platforms of bridges.

The first consideration will be the form and size of the cross girders which transmit the load from the roadway to the main girders. It would at first sight appear that these cross girders may be regarded as fixed at both extremities, and in many cases it would be accurate so to do; but in the first which we shall consider a different course must be adopted.

Let us suppose that a roadway is required for a bridge carried by two longitudinal or main girders; then the cross girders used to support such roadway may be treated as ordinary straight girders supported at each end. Let the distance between the two main girders be represented by b, the load per square foot of the platform being w, and the distance between any two consecutive cross girders n feet; then will the total load upon any cross girder evidently be

$$= w\, b\, n.$$

Let the depth of the cross girder in inches be $= d$, then the strain at any point on either flange will be (the web being omitted)

$$= w\, b\, n\, \frac{b\, x}{d} \left\{ x - b \right\}$$

where $x =$ the distance from one end of the cross girder to the point at which the strain is required. Let us now proceed to determine the most convenient arrangement of cross girders for an ordinary road bridge.

In determining the system of construction to be followed, the general desiderata to be borne in mind are, that the depth between the centres of gravity of the flanges should be about one twelfth of the span of the cross girders; that the load should be distributed over as many points as possible in the main girders; and that the number of cross girders should be such that there is no unnecessary loss of metal in them. The general arrangement may be found in the following manner.

Let the distance between the main girders be 20ft., the weight per square foot 200lbs., the depth of the girder 20in.; the strain on either flange at the centre will then be

$$= \frac{3\, w\, b^2\, n}{2\, d}$$

$$= \frac{3 \times 200 \times \overline{20}^2 \times n}{2 \times 20}.$$

It is desirable to distribute the load over as many points in the main girders as possible—or, in other words, it is advantageous to have as many cross girders as may conveniently be applied. Let us suppose that the web of the cross girder be of $\frac{1}{4}$in. plate, and the flanges of two 4in. by 3in. angle iron, $\frac{1}{2}$in. thick, the same dimensions being used throughout; then by rules already established the strength of such a girder would be as follows:—Let $a =$ sectional area of one flange in inches, W = total equally distributed load which may be safely carried by the girder; the resistance of the metal to tension and compression will be taken 8960lbs. per square inch of gross sectional area; then

$$a = 2 \left\{ 4 + 2{\cdot}5 \right\} \tfrac{1}{2},$$

$$= 6{\cdot}5 \text{ square inches,}$$

of which the direct resistance will be,

$$= 6{\cdot}5 \times 8960,$$

$$= 58{,}240 \text{ lbs.};$$

but the resistance must be equivalent to the strain; hence by equating the least quantity with that which represents the strain, we have,

$$58{,}240 = 6000\, n;$$

therefore,

$$n = \frac{58240}{6000},$$

$$= 9{\cdot}706;$$

or the cross girders must not be more than 9·706 feet asunder. The expression for n will of course be generally derived thus:—

$$\frac{3\, w\, b^2\, n}{2\, d} = 8960\, a.$$

Therefore

$$n = \frac{2 \times 8960\, a\, d}{3\, w\, b^2}$$

$$= 5973{\cdot}33 \cdot \frac{a\, d}{w\, b^2};$$

which, in the above case, would give—

$$n = 5973{\cdot}33\, \frac{6{\cdot}5 \times 20}{200 \times \overline{20}^2}$$

$$= 9{\cdot}706 \text{ feet,}$$

as before. Thus we see that the distance between the girders may most readily be determined, the other particulars being known. Any dimension may however be found from the following expression when the others are given:—

$$n = 5973{\cdot}33\, \frac{a\, d}{w\, b^2}$$

$$w = 5973{\cdot}33\, \frac{a\, d}{n\, b^2}$$

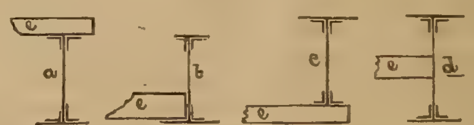
$$a = \frac{w\, b^2\, n}{5973{\cdot}73\, d}$$

$$b = \sqrt{5973{\cdot}33\, \frac{a\, d}{w\, n}}$$

$$d = \frac{w\, b^2\, n}{5973{\cdot}33\, a}$$

The dimensions of the cross girders being known, it becomes necessary to arrange the means of attaching them to the main girders. The methods most commonly adopted are as follows:—By placing the cross girders upon the main girders, and there bolting or rivetting them; by placing them upon the bottom flange of the girder, and fixing with bolts or rivets; by bolting or rivetting them beneath the bottom flange; and by fixing them to the web of the main girder by brackets. These methods are illustrated by the sections, fig. 1.

FIG: 1.



a shows the first, b the second, c the third, and d the fourth method; e in each section indicating the position of one extremity of the cross girder; Of these arrangements we prefer those shown at a and c, as the others appear liable to give rise to unequal straining of the main girders; whereas, by the adoption of the former, an uniform effect is obtained. The total sectional area of the bolts is easily obtained. First, let them be used as suspenders, as in the method employed in c; then as wrought iron may be loaded safely with 5 tons per sectional square inch, it follows that the total area of all the bolts will be

$$= \frac{w\, b\, n}{11200}$$

Hence, if m bolts in all (that is to say at both ends) be used, the diameter of each will be

$$= \sqrt{\frac{w\, b\, n}{m\, 11200 + {\cdot}7854}}$$

This formula is calculated upon the assumption that the bolt is equally strong in every part; in order to insure which the following precautions must be attended to. The breaking strain to draw off the head must not be less than the tensile strength of the bolt itself, nor must the thread be weaker, and the proportions requisite to insure these points may be determined as follows:—Let the strength of wrought iron be taken at 5 tons per square inch in tension, and 4 tons to resist shearing strains; the resistance of the centre of a bolt, of which the diameter is D inches, will be

$$= 0{\cdot}7854\, D^2 \times 5$$

$$= 3{\cdot}927\, D^2$$

$$= 4\, D^2, \text{ nearly.}$$

The resistance offered by the head of which the length is h will be

$$= 3{\cdot}1416\ D\ h \times 4$$
$$= 12{\cdot}5664\ D\ h$$
$$= 12{\cdot}6\ D\ h, \text{ nearly.}$$

As these two quantities should be equal, we have the equation

$$4\ D^2 = 12{\cdot}6\ D\ h;$$

therefore,

$$h = \frac{4}{12{\cdot}6} \cdot D$$
$$= \frac{D}{3{\cdot}15}$$

Hence we may say that the height of the head of the bolt should not be less than one third of the diameter of the same, and it will generally be found convenient not to make it less than one-half. With regard to the nut a similar calculation may be applied; but in this case it must be remembered that about half the area is lost in cutting the screw; or we may suppose the inefficient surface between the thread to be equal to the base of the thread, hence the height of the nut must not be less than two thirds the diameter of the bolt, and it may generally be made equal to the diameter, in order to insure safe results. Similar remarks apply to the formation of rivets, in which the effective height of the head should never be less than one-third the diameter of the rivet, and this proportion will usually make the central or greatest height of the head equal to half the diameter. When such an arrangement as that shown at d is used, the supporting bolts are subject to shearing strain, to which their resistance is but four-fifths of the resistance to tension; hence it follows that the sectional area of all the supporting bolts will be required to be

$$\frac{w\ b\ n}{8960} \text{ square inches.}$$

From this expression such others as may be requisite are easily obtained.

(*To be continued.*)

USEFUL NOTES AND FORMULÆ FOR ENGINEERS.

The molecules of a rigid body are connected by a force termed th attraction of cohesion, and when this force is overcome, and the particles of the body separated beyond the sphere of their mutual attraction, that substance is said to be ruptured or broken.

The strains which tend to produce rupture are five in number, viz.:—tensile, compressive, transverse, shearing, and torsional.

A tensile strain is that produced by a force tending to pull the particles of a body from each other; a compressive force brings them into closer proximity to each other; a transverse strain is produced by a force acting at right angles to the body, such as bridges, joists, cantilevers, &c., are subject to; a shearing strain is that produced when a substance is cut across; torsion is produced by twisting, as in shafts, &c.

All substances possess the property of elasticity within certain limits, that is to say, a tendency to return to their original form and size, when acted upon by any force. These limits vary for every substance; thus, steel wire will, when properly tempered, resume its original form, after a much greater alteration than that which iron will sustain.

Materials are said to be perfectly elastic when the extension or compression is proportional to the force producing it, and equal resistance is offered to extension and compression. This is very nearly the case with wrought iron.

A substance may be extended or compressed to a degree exceeding the limits of elasticity without effecting rupture, but in this case the body does not resume its original form, and it is said to have sufferred a permanent set; this should never be permitted in practice, as the ultimate strength is thereby deteriorated.

All our theoretical calculations respecting the strength of materials are based upon the assumption that the property of perfect elasticity belongs to those bodies which are employed in construction; it is therefore necessary to have some datum from which we may calculate the effect of the various strains to which materials are subjected. The modulus of elasticity is that force which is necessary to elongate a bar one square inch in section to twice its length, which, although impossible in practice, forms, when obtained by calculation, a very convenient datum. Formulæ will be furnished hereafter for calculating the modulus of elasticity.

Let it be required to find the extension or compression of a given bar. produced by force acting in the direction of its length:

Let E = modulus of elasticity,
L = length of bar,
l = elongation with a
force p = weight in pounds

∴ force to produce an elongation of L inches = E

$$\text{Force to produce an elongation of 1 inch} = \frac{E}{L}$$

$$\text{,, \quad , \quad ,, \quad } l \text{ inches} = \frac{E\ l}{L}$$

$$\therefore p = \frac{E\ l}{L}$$

If the bar be of one square inch sectional area; but if the area contains A square inches, the force to produce an elongation of l inches

$$= A\ p$$

Calling this force = P

$$P = A\ p = \frac{A\ E\ l}{L}, \text{ and}$$

$$l = \frac{P\ L}{A\ E}$$

NEUTRAL AXIS IN STRAIGHT GIRDERS.

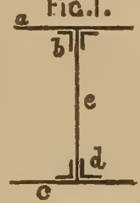
If a beam is subjected to a transverse strain, two kinds of forces are brought into operation, viz.:—compressive on the fibres in one part of the beam, and tensile on those in the other part.

If a beam supporting a load is fixed at one end, no support being afforded at the other, the upper fibres suffer a tensile strain, and the lower are compressed, but, if the beam is supported at both ends the reverse takes place.

In either of these cases it is evident that there can be no strain at that part of the beam, where the tensile strain ceases and the compressive begins to act, this part is termed the neutral axis, or perhaps more correctly the neutral surface.

When the elasticity of the material is perfect the neutral axis passes through the centre of gravity of the section, and may be found as follows:—

Fig. 1.



Let it be required to find the neutral axis of any section, as in Fig 1.

Let x = distance of neutral axis from bottom of girder,
a = area of top flange,
b = area of top angle iron,
e = area of top of web,
D = depth of girder,
c = area of bottom flange,
d = area of bottom angle irons.

Then if M a M b etc., represent the moments of the various parts of the section about an axis taken at the bottom of the section,

$$x = \frac{Ma + Mb + Me + Mc + Md}{a + b + e + c + d}$$

for it is evident that the moment of the gravitating force of the whole section is equal to the sum of the moments of each element, and also it is equal to the area of the section multiplied by the distance of its centre of gravity, from the axis round which the moments are taken.

We will now show the method of finding the moment of each part of the section:—

Let l = depth of the girder,
$t\ t'$ = thickness of top and bottom flanges,
t'' = thickness of web,
y = distance of any infinitely small area from the bottom of the girder.

then if B = the breadth of any rectangular area, and M = its moment,

$$M = B\ y\ \Delta\ y$$

Δ y represent the depth of the element, and being infinitely small.
The moment of the whole rectangle,

$$= B\ \Sigma\ y\ \Delta y$$

which being integrated for the flange a, will become; when

$$l - t = e'$$

$$B\int_{e'}^{l} y\ \Delta\ y = \frac{B}{2}\ (l^2 - l'^2) = M\ a$$

and for the flange c,

$$B\int_{o}^{t'} y\ \Delta\ y = \frac{B\ t'^2}{2} = M\ c$$

for the web,

$$B\int_{t'}^{e'} y \,\Delta\, y = \frac{t''}{2}(e'^2 - t'^2) = Me$$

The other moments may be similarly found, after which they are to be added together and divided by the total area of the section, which will give the value of x.

The general formulæ may be thus stated :—

The moment of the gravitating forces acting upon any rectangle to cause it to revolve round one of its sides,

$$= \frac{b\,d^2}{2}$$

where b = the breadth of the rectangle
d = the depth of the rectangle

the moment also,

$$= A\,x$$

where A = area of rectangle
and x = distance of its centre of gravity from the axis around which it revolves.

therefore,

$$A\,x = \frac{b\ d^2}{2}$$

$$\therefore\ x = \frac{b\ d^2}{2} \times \frac{1}{A}$$

In this particular case

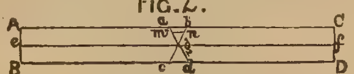
$$A = b\,d$$

$$\therefore\ x = \frac{d}{2}$$

hence we find that in sections which are symmetrical the neutral axis passes through the centre of the section.

Moment of Inertia.

FIG. 2.



Let A B C D represent a beam of rectangular section undergoing a transverse strain, and supported at B and D.

We will assume the beam to be composed of longitudinal fibres parallel to A C, then if *ef* represents the neutral axis, the fibres above it A *ef* C, will be compressed, while those in B *ef* D are extended and the triangles *a b g*, *c d g* will represent the comparative amount of compression and extension.

As extension and compression is proportional in amount, to the weight producing it, and it is evident that the fibre *a b* is more compressed than *m n*, there is a greater strain on *a b* than on *m n*, and as the forces of strain and resistance are in equilibrium, the resistance of the fibre *a b* is greater than the resistance of *m n* in the ratio of their distances from the neutral axis.

Let h = distance of neutral axis from top of beam.
b = breadth of beam.
s = force per square inch exerted by the material at a distance h from the neutral axis.
$x = g\,n$, a variable distance.

Compressive force per square inch at a unit from $g = \frac{s}{h}$

Compressive force per square inch at x units from $g = \frac{s}{h}x$.

Area of an element of surface at $m = b\,\Delta\,x$ compressive resistance of this surface.

$$= \frac{s}{h}\,b\,x\,\Delta\,x$$

But to find the effect of any force tending to turn a body round any point, we must consider the leverage with which it acts, or in other words we must find the moment of the force round g, by multiplying that force by its distance from the neutral axis, the distance is equal to x, and the moment of the above force is—

$$= \frac{s}{h}\,b\,x^2\,\Delta\,x.$$

if we apply this process to all the fibres in *a b g*, we shall obtain the moment of resistance of that portion of the section which is above the neutral axis, let Φ represent this moment, and using Σ as a sign of summation we have

$$\phi = \frac{s\,b}{h}\ \Sigma\,x^2\,\Delta\,x \quad .\ .\ .\ .\ .\ (1.)$$

but of this equation the part $b\,\Sigma\,x^2\,\Delta\,x$ is called the moment of inertia of the section *a g*, but if we sum the forces of all the fibres in the section *a c*, it will represent the moment of inertia of the whole section, calling this = I, we have

$$\phi = \frac{s}{h}\,I \quad .\ .\ .\ .\ .\ .\ .\ .\ (2.)$$

which gives the moment of the resistance at any section of the beam, in terms of the longitudinal strain on the fibre *a b*.

We now proceed to obtain the moment of inertia for various sections.

Moment of inertia for a rectangular section.

Let d = depth of the beam.
b = breadth of the beam.

Integrating the general equation for the moment of inertia obtained from *e g* (1) between $\frac{d}{2}$ and o,

$$I = \int_o^{\frac{d}{2}} b\,x^2\,\Delta\,x,$$

we obtain,

$$I = \frac{b\,x^3}{3};$$

but

$$x = \frac{d}{2};$$

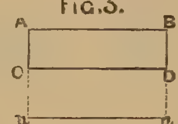
$$\therefore I = \tfrac{1}{3}\,b \times \left(\frac{d}{2}\right)^3 = \frac{b\,d^3}{24};$$

which is the moment of inertia for half the section, the moment for the whole section will therefore be,

$$= \frac{b\,d^3}{24}$$

Moment of inertia of a solid rectangle.

FIG. 3.

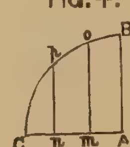


Let A B C D represent the solid rectangle, *n a* the neutral axis, h = A n, and $e = c\,n$ then,

$$I = \frac{b}{3}\,(h^3 - e^3)$$

Moment of inertia for a circular section.

FIG. 4.



Let A B C represent a quadrant, and *a c* the neutral axis, A being the centre of the circle.

Let r = radius, x = A m, $y = o\ m\ o\ p\ n\ m$ a small element, $\Delta\,x = m\,n$, then,

$$I = \tfrac{1}{3}\,\Sigma\,y^3\,\Delta\,x,$$

for all the elements in A B C,

$$\therefore I = \tfrac{1}{3}\int y^3\,h\,x \quad .\ .\ .\ .\ .\ (3)$$

By the equation to the curve we have,

$$y = \sqrt{r^2 - x^2}$$

$$y^3 = (r^2 - x^2)^{\frac{3}{2}}$$

substituting in equation (3),

$$I = \tfrac{1}{3}\int_o^r (r^2 - x^2)^{\frac{3}{2}}\,d\,x$$

$$= \frac{\pi\,r^4}{16}$$

and for the whole circle,

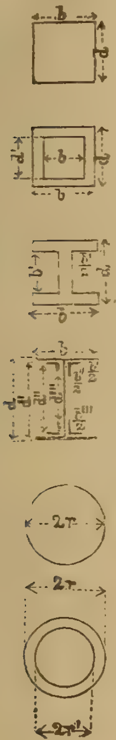
$$I = \frac{\pi\,r^4}{4}$$

Formulæ for moment of inertia.

If the sections treated of above are not solid, we must subtract the moments of inertia for the hollow portions from the moments of inertia for the whole section, which will give the moment for the hollow section.

The following are the formulæ for the moments of inertia for various sections.

FIG. 5.



$$I = \frac{b\,d^3}{12}$$

$$I = \frac{b\,d^3 - b'\,d'^3}{12}$$

$$I = \frac{b\,d^3 - b'\,d'^3}{12}$$

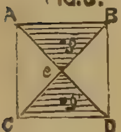
$$I = \frac{b\,d^3 - (b'\,d'^3 + b''\,d''^3 + b'''\,d'''^3)}{12}$$

$$I = \frac{\pi\,r^4}{4}$$

$$I = \frac{\pi\,(r^4 - r'^4)}{4}$$

Geometrical method of finding the moment of inertia.

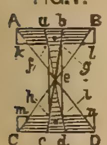
FIG. 6.



Let A B C D represent a section of a rectangular beam, join A D and B C, then the areas of the triangles A *e* B, C *e* D, will respectively represent the resistances of all the fibres compressed and extended, and each area being multiplied by the distance of its centre of gravity, and from the neutral axis, the sum of the two products will be the moment of inertia of the section.

Moment of inertia for a girder with equal flanges.

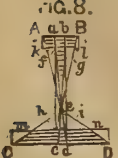
FIG. 7.



Let A B C D, Fig. 7, represent a girder with equal flanges. Join A D, B C, *a d*, and *b c*, then the area of the figure A *k f e g e* B multiplied by the distance of its centre of gravity from the neutral axis *e*, plus the area of the figure C *m h e i n* D, multiplied by the distance of its centre of gravity from the neutral axis, will be the moment of inertia for the section.

Moment of inertia for a girder with unequal flanges.

FIG. 8.



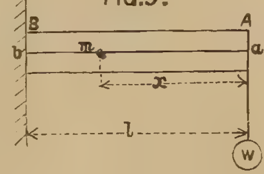
If the material of which the girder is constructed will not bear equal strains in tension and compression, the girder should not have equal flanges; thus, if the substance will only sustain extension through one-fourth the space though which it may be compressed without fracture, the section should be such that the neutral axis is four times as distant from the top as from the bottom of the girder; so that the material will be extended only one-fourth the amount it is compressed. If the beam, instead of being supported at both ends, is only supported at one end, the position must be reversed. Let A B C D, Fig. 8, be a section of a girder proportioned as above; to find the moment of inertia, we proceed in manner similar to that applied to the girder with equal flanges.

Moments of strain.

The moments of external forces are those produced upon a beam by a load, which tends to turn the whole, or part of it, round a point in the neutral axis, and to maintain the equilibrium of the structure. The moment of resistance must be equal to the moment of strain.

Moments of strain on a beam, fixed at one end.

FIG. 9.



Let A B represent a beam, fixed at one end, of which *a b* is the neutral axis. To find the moment M round any point *m*, at a distance *x*, from the end A, of the girder, produced by a load W, at the extremity of the girder, we have—

$$M = W\,x$$

If $x = l$, the point *m* being at the end B of the girder.

$$m = W\,l$$

which is the greatest strain to which the beam is subject. Instead of being loaded at the end, let the beam be acted upon by an uniformly distributed load, equal to *w*, per lineal foot, then the strain at any point is,

$$M = \frac{w\,x^2}{2},$$

obtained by multiplying the load $w\,x$ by its mean leverage $\frac{w}{2}$, if $x = l$

$$M = \frac{w\,l^2}{2};$$

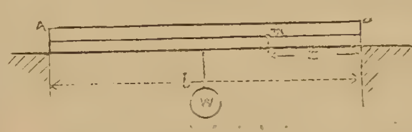
or calling W the total load,

$$M = \frac{W\,l}{2};$$

which is the maximum strain.

Moments of Strain on a Beam supported at Both Ends.

FIG. 10.



Let A B represent a beam supported at both ends, and loaded with a weight W at the centre. To find the moment round any point *m*, we multiply the reaction of the pier B by the leverage *x*.

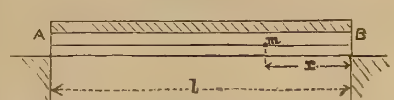
$$\therefore M = \frac{W\,x}{2}.$$

If *m* is at the centre of the beam $x = \frac{l}{2}$, then

$$M = \frac{W\,l}{4};$$

which is the maximum strain.

FIG. 11.



Let the beam A B be subject to an uniformly distributed load equal *w* per lineal foot; we have two forces acting round *m*—one equal to the reaction of the pier B, which acts upwards with a leverage *x*, the moment of which is,

$$= \frac{w\,l\,x}{2},$$

and another acting downwards, equal to the part of the load $w\,x$, which has a leverage of $\frac{x}{2}$, and therefore,

$$= \frac{w\,x^2}{2};$$

subtracting this from the former, we have,

$$M = \frac{w\,l\,x}{2} - \frac{w\,x^2}{2} = \frac{w}{2}\,(l\,x - x^2);$$

if m be at the centre of the girder $x = \frac{l}{2}$; then,

$$M = \frac{w}{2}\left(\frac{l^2}{2} - \frac{l^2}{4}\right) = \frac{w\,l^2}{8};$$

calling W the total load,

$$M = \frac{W\,l}{8}.$$

Moments of Strain on Continuous Girders.—General Theory.

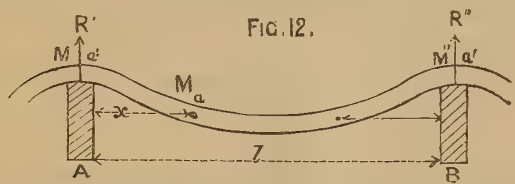


Fig. 12.

Let A B fig. 12 represent one span of a continuous girder supported at equal intervals, for which

w = load per lineal foot.
l = span.
$R'\ R''$ = reactions on the piers A and B.
$M'\ M''$ = moments of strain round points situated above A and B.
$a'\ a''$ = tangents to the angles formed with the horizontal at A B by tangents to the deflected beam.
$M\ a$ = similar values for a point distant x from A.

To find the moment M we take the moment M' plus the load $w\,x$, multiplied by its leverage $\frac{x}{2}$, both acting round M in the same direction, and subtract the reaction R' multiplied by its leverage x, which moment tends to turn the part x of the beam in the opposite direction. Then,

$$M = M' + \frac{w\,x^2}{2} - R'\,x \quad . \quad . \quad . \quad . \quad . \quad (4.)$$

In this equation we have the unknown quantities M' and R', which must be eliminated. Make $x = l$, and find the moment of strain at B.

$$M'' = \frac{w\,l^2}{2} - R'\,l + M' \quad . \quad . \quad . \quad . \quad . \quad (5.)$$

transposing,

$$R' = \frac{w\,l^2}{2} + \frac{M' - M''}{l}$$

replacing R' in (4), we have,

$$M = M' + \frac{w\,x^2}{2} - \left(\frac{w\,l}{2} + \frac{M' - M''}{l}\right)x \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

But in any beam of any section, loaded in any manner, the moment M at any point is equal to the moment of resistance of the molecular forces at that point; as if this were not the case, the conditions of equilibrium would not be satisfied.

The moment of resistance is represented by $\frac{e\,d^2 y}{d\,x^2}$ in which e represents the moment of elasticity, obtained by multiplying the moment of inertia by the modulus of elasticity of the material employed.

$$\therefore M = \frac{e\,d^2 y}{d\,x^2},$$

substituting this in equation (6),

$$\frac{e\,d^2 y}{d\,x^2} = M' + \frac{w\,x^2}{2} - \left(\frac{w\,l}{2} + \frac{M' - M'}{l}\right)x.$$

integrating, we obtain,

$$\frac{e\,d\,y}{d\,x} = \frac{w\,x^3}{6} - \left(\frac{w\,l}{2} + \frac{M' - M''}{l}\right)\frac{x^2}{2} + M'\,x + c;$$

in which c represents a constant. If we divide by e $\frac{d\,y}{d\,x} = d$, and when $x = o$ $\frac{d\,y}{d\,x} = d'$, therefore d' is the constant.

$$\frac{d\,y}{d\,x} = \frac{w\,x^3}{6\,e} - \left(\frac{w\,l}{2} + \frac{M' - M''}{l}\right)\frac{x^2}{2\,e} + \frac{M'\,x}{e} + a \quad . \quad . \quad . \quad (7.)$$

and when $x = l$

$$\frac{d\,y}{d\,x} = a'' = \frac{w\,l^3}{6\,e} - \left(\frac{w\,l}{2} + \frac{M' - M''}{l}\right)\frac{x^2}{2\,e} + \frac{M'\,l}{e} + d.$$

which by reduction becomes,

$$\frac{d\,y}{d\,x} = a'' = -\frac{w\,l^3}{12\,e} + \left(M' + M''\right)\frac{l}{2e} + d' \qquad (8.)$$

Integrating equation (7) the second time we have,

$$y = \frac{w\,x^4}{24\,e} - \left(\frac{w\,l}{2} + \frac{M' - M''}{l}\right)\frac{x^3}{6\,e} + \frac{M'\,x^2}{2\,e} + a'\,x + c \qquad 9.)$$

The constant in this case equals o; for when $x = o$ $y = o$. Making $x = l$ we have,

$$y = \frac{w\,l^4}{24\,e} = \left(\frac{w\,l}{2} + \frac{M' - M''}{l}\right)\frac{l^3}{6\,e} + \frac{M'\,l^2}{2\,e} + a\,l$$

but when $x = l$, $y = o$. Reducing the above, we ave,

$$o = -\frac{w\,l^4}{24\,e} - (2\,M' + M'')\frac{l^2}{6\,e} + a\,l$$

$$a'\,l = \frac{a\,l^4}{24\,e} - \frac{l^2}{6\,e}(2\,M' + M'')$$

$$a' = \frac{w\,l^3}{24\,e} - \frac{l}{6\,e}(2\,M' + M'')$$

replacing a' in (8).

$$a'' = -\frac{w\,l^3}{12\,e} + (M' + M'')\frac{l}{2\,e} + \frac{w\,l^3}{24\,e} - \frac{l}{\ } \quad M + M\ )$$

end reducing,

$$a'' = -\frac{w\,l^3}{24\,e} + \frac{l}{6\,e}(M' + 2\,M'') \quad . \quad . \qquad 1$$

Now, if we call

$$a\begin{cases} a' = \dfrac{l^3}{24\,e}\,\theta' \\ M' = \dfrac{Q\,l^2}{4} \end{cases} \text{ and } \begin{cases} a'' = \dfrac{l^3}{24\,e} \\ M' = \dfrac{Q}{4} \end{cases}$$

Substituting these values in (10) and (11) we find,

$$\theta' = w - 2\,g - g''.$$

$$\theta'' = w - g' + 2\,g''.$$

From these we obtain,

$$Q'' = w - 2\,g' - \theta' \quad . \quad . \quad . \quad . \quad . \quad . \quad (12.)$$

$$\theta'' = w - 3\,g' - 2\,\theta' \quad . \quad . \quad . \quad . \quad . \quad . \quad (13.$$

Thus knowing g' and θ' on a given pier we can always find the next pier, and by the relation (a) we can find a'' and M .

We will proceed in our next to apply these formulæ.

(*To be continued.*)

STRENGTH OF MATERIALS.

DEDUCED FROM THE LATEST EXPERIMENTS OF BARLOW, BUCHANAN FAIRBAIRN, HODGKINSON, STEPHENSON, MAJOR WADE, U.S. ORDNANCE CORPS, AND OTHERS.

BY CHARLES H. HASWELL, C.E.

(From the *Journal of the Franklin Institute.*)

(*Continued from page* 12.)

CRUSHING STRENGTH.

To ascertain the Crushing Strength of a Solid Cylindrical Column of Cast Iron.

$$\frac{d^{3\cdot6}}{l^{1\cdot7}} \times 100000 = W,$$

d representing the diameter of the column in inches, l its length in feet, and W the crushing weight.

EXAMPLE.—What is the resistance to crushing of a solid cylinder 2in. in diameter and 5ft. in length?

$$\frac{2^{3\cdot6}}{5^{1\cdot7}} = \frac{12\cdot125}{15\cdot426} \times 100000 = 78601 \text{ lbs.}$$

To ascertain the Crushing Strength of a Hollow Cylindrical Column of Cast Iron.

$$\frac{D^{3\cdot6} - d^{3\cdot6}}{l^{1\cdot7}} \times 100000 = W,$$

D representing the greatest diameter.

EXAMPLE.—What is the resistance to crushing of a hollow cylindrical column having diameters of 2in and 1·25in., and a length of 7ft.?

$$\frac{2^{3\cdot6} - 1\cdot25^{3\cdot6}}{7^{1\cdot7}} = \frac{12\cdot125 - 2\cdot233}{27\cdot332} \text{ which } \times 100000 = 36190.$$

The above formulæ are those of Hodgkinson for the breaking or crushing weight. The formulæ of Euler, which are for the incipient breaking weight, are preferable, and are, with the alteration of the co-efficient, thus:

$$\frac{d^4}{l^2} \times 100000 = W \text{ for solid cylinders, and}$$

$$\frac{D^4 - d^4}{l^2} \times 100000 = W \text{ for hollow cylinders.}$$

The safe load that may be borne by a column of cast iron, independent of any considerations, regarding the operation of its ends as to their being square or not, or flat, or rounded, &c., is from 5000lbs. to 8000lbs. per square inch for short or stable bodies.

NOTE.—The above formulæ apply to all columns where the length is not less than about 30 times the external diameter; for columns shorter than this, a modification of the formulæ is necessary, as in shorter columns the breaking weight is a large portion of that necessary to crush the column.

Thus. A column has two functions—one to support weight, and the other to resist flexure: it follows, then, that when the pressure necessary to break the column is very low on account of the extreme length of it, compared with its diameter or depth, then the strength of the whole transverse section of the column will be exerted in resisting flexure. When the breaking pressure is half of what would be required to crush the material, one-half only of the resistance may be considered as available to resist flexure, the other half being exerted in crushing; but when, through the shortness of the column, the breaking weight is so great as to be nearly equal to the crushing force, a very little, if any, portion of the resistance or strength of the column is applied or exerted in resisting flexure.

To Ascertain the Weight that may be safely borne by Columns of various Dimensions and Materials.

RECTANGULAR COLUMNS.

Cast Iron, $\dfrac{16000\, l\, b^3}{4\, b^2 + \cdot18\, l^2} = W.$

Wrought Iron, $\dfrac{18000\, l\, b^3}{4\, b^2 + \cdot16\, l^2} = W.$

Oak, $\dfrac{4000\, l\, b^2}{4\, b^2 + \cdot5\, l^2} = W.$

SOLID CYLINDERS.

Cast Iron, $\dfrac{10000\, d^4}{4\, d^2 + \cdot18\, l^2} = W.$

Wrought Iron, $\dfrac{11200\, d^4}{4\, d^2 + \cdot16\, l^2} = W.$

Oak, $\dfrac{2500\, d^4}{4\, d^2 + \cdot5\, l^2} = W.$

HOLLOW CYLINDERS.

Cast Iron, $\dfrac{16000\, D^4 - d^4}{4\, D^2 + \cdot18\, l^2} = W.$

Wrought Iron, $\dfrac{11200\, D^4 - d^4}{4\, D^2 + \cdot16\, l^2} = W.$

Oak, $\dfrac{2500\, D^4 - d^4}{4\, D^2 + \cdot5\, l^2} = W.$

l representing the length in feet, b the breadth, and D and d the diameter in inches, and W the weight in pounds.

EXAMPLE.—What are the crushing weights that may be safely borne by a cast iron, wrought iron, and oak rectangular column 2in. square and 5ft. in height?

$$\frac{16000 \times 5 \times 2^3}{4 \times 2^2 + (\cdot18 \times 5^2)} = \frac{16000 \times 5 \times 8}{32 + 4\cdot5} = 17534 \text{ lbs. for the cast iron.}$$

$$\frac{18000 \times 5 \times 2^3}{4 \times 2^2 + (\cdot16 \times 5^2)} = \frac{18000 \times 5 \times 8}{32 + 4} = 20000 \text{ lbs. for the wrought iron.}$$

$$\frac{4000 \times 5 \times 2^3}{4 \times 2^2 + (\cdot5 \times 5^2)} = \frac{4000 \times 5 \times 8}{32 + 12\cdot5} = 3596 \text{ lbs. for the oak.}$$

Table showing the Weight or Pressure a Column of Cast Iron will sustain with safety.

	LENGTH OR HEIGHT IN FEET.								
Inch.	4	6	8	10	12	14	16	18	20
2·5	13,923	12,285	10,647	9,009	7,605	6,435	5,499	4,680	3,978
3·	20,826	19,071	16,965	14,976	12,987	11,349	9,828	8,541	7,488
3·5	28,899	27,144	25,038	22,317	20,124	18,252	15,975	13,923	12,402
4·	38,142	36,270	33,696	31,122	28,314	25,740	23,166	20,826	18,720
4·5	48,906	46,800	44,343	41,418	38,259	35,217	32,175	29,367	26,793
5·	61,074	58,617	56,043	52,884	49,959	46,098	42,705	39,439	36,270
6·	71,019	69,264	67,041	64,350	61,425	58,149	54,873	51,480	48,321
7·	120,744	118,521	115,713	112,203	108,108	103,779	99,216	94,536	89,505
8·	155,961	153,855	150,813	147,303	143,208	138,645	133,614	128,349	123,084
9·	200,772	198,549	195,624	191,880	187,551	182,637	177,255	171,639	165,672
10·	247,923	245,700	243,009	239,265	234,819	229,788	224,172	218,205	211,887
11·	300,690	298,350	294,840	291,330	286,650	281,970	275,886	269,685	263,016
12·	356,850	355,680	353,340	347,490	342,810	339,300	331,110	325,260	319,410

Table exhibiting the Relative Value of various Woods, their Crushing Strength and Stiffness being combined.

Teak	6555	American Spruce	2522
English Oak	4074	Walnut	2378
Ash	3571	Yellow Pine	2193
Elm	3468	Larch	1897
Beech	3079	Sycamore	1833
Quebec Oak	2927	Poplar	975
Spanish Mahogany	2571	Cedar	700

Comparative Strength of Long Columns of various Materials.

Cast Iron	1000	Oak	108·8
Wrought Iron	1745	Pine	78·5
Cast Steel	2518		

Results of Experiments

To determine the Resistance of Rectangular and Cylindrical Tubes of Wrought Iron to a Crushing Force applied horizontally in the direction of their Length.

Length of Tubes.	External Dimensions.	Thickness of Metal.	Weight of greatest Resistance.	Area of Section.	Weight per square inch of greatest Resistance.	Weight per sq. in. at which Deflection was observed.
Rectangular.						
ft. in.	inches.	inches.	lbs.	sq. in.	lbs.	lbs.
10 0	4·1 × 4·1	·03	5,534	·504	10,980	
5 0	4·1 × 4·1	·03	5,803	·504	11,514	
2 6	4·1 × 4·1	·03	6,251	·504	12,403	
10 0	4·25 × 4·25	·134	51,690	2·395	21,585	46,314
10 0	8·4 × 4·25	·26 × ·126*	206,571	6·89	29,981	99,916
10 0	8·5 × 8·375	·2191	198,955	7·7367	25,716	
Cylindrical.						
		Internal diam.				
9 11	1·495	1·292	6,514	·4443	14,661	
5 0	1·495	1·292	13,860	·4443	31,195	
2 6	1·495	1·292	15,204	·4443	34,221	
9 11	2·995	2·693	37,350	1·349	27,691	
2 4	3·	2·712	52,874	1·414	37,393	
5 0	3·995	3·504	86,922	2·895	30,025	
5 0	3·995	3·513	98,122	2·848	34,453	
2 4	4·	3·5	136,202	2·848	47,823	

* Greatest thickness and least depth laid horizontally.

Bridges.

Iron bridges with a circular arc should have a rise of ·1 of the chord line, and a width of pier of ·1 of span.

Girders combined with Suspension Chains (P. W. Barlow).

In a suspended girder the stress is resisted by back chains or wire rope.

A suspension girder designed for the Londonderry bridge, was rendered equally rigid with a simple girder with less than $\frac{1}{25}$ of the metal required in the girder above; and from experiments upon a model of the bridge it was deduced that the deflection of one of the girders when suspended was about $\frac{1}{25}$ of that when the suspension was detached; and, as the girder in the experiment was only suspended at one point, this deflection would be further reduced by suspension at several points, as in the bridge itself.

In suspension bridges it is essential that the platform should be made as rigid as practicable, to arrest vertical undulations.

The economy of metal in a suspension bridge under the average circumstances of its attainable depth is from one-fourth to one-half of that in a tubular or simple girder bridge of equal strength and rigidity.

Comparison between the Two Largest Railway Bridges yet constructed.

Niagara (Wire). Having a roadway and a single railway of three gauges in a span of 820ft; weighs 1000 tons.

Britannia (Tubular). Having a double line of railway in a span of 460ft, weighs 3000 tons.

Trussed Beams or Girders.

Wrought and cast iron possess different powers of resistance to tension and compression, or have different tensile and crushing strengths; and when a beam is so constructed that these two materials act in unison with each other *at the stress due to the load required to be borne*, their construction will effect an essential saving of material.

In consequence of the difficulty of adjusting a tension rod to the strain required to be resisted, it is held to be impracticable to construct a perfect truss beam; for, if too high a tension is given to the rod or rods, they will part before the beam has been strained to its yielding point; and, on the contrary, if too low a tension is given to them, the beam will break before it has been strained to its yielding point.

Fairbairn declares that it is better for the tension of the truss rod or rods to be low than high, which position is fully supported by the following elements of the two metals:—

Wrought iron has great tensile strength, and, having great ductility, it undergoes much elongation when acted on by a tensile force. On the contrary, *cast iron* has great crushing strength, and, having but little ductility, it undergoes but little elongation when acted on by a tensile force; and, when these metals are released from the action of a high tensile force, the *set* of the one differs widely from that of the other, that of the wrought iron being the greater. Under the same increase of temperature the expansion of wrought is considerably greater than that of cast iron; 1·81* tons per square inch is required to produce in wrought iron the same extension as in cast iron by 1 ton.

The relative tensile strengths of cast and wrought iron being as 1 to 3, and their resistance to extension as 1 to 1·81, therefore, where no initial tension is applied to a truss rod, the cast iron must be ruptured before the wrought iron is sensibly extended.

Fairbairn, in his experiments upon English metals, shows that with a strain of about 12,320 lbs. per square inch on cast iron, and 28,000lbs. on wrought iron, the sets and elongations are nearly equal to each other; and for strains below 12,320 lbs. and 28,000 lbs., the set of cast iron is greater than that of wrought iron, and for strains above these, the set of wrought iron is the greatest.

From other experiments, he deduced that within the limits of strain of 13,440 lbs. per square inch for cast iron, and 30,240 lbs. per square inch for wrought iron, the tensile force applied to wrought iron must be 2·25 times the tensile force applied to cast iron, to produce equal elongations.

The resistance of the cast iron in a trussed beam is not wholly that of tensile strength, but it is a combination of both tensile and crushing strengths, or a transverse strength; *hence*, in estimating the resistance of a girder, the transverse strength of it is to be used in connection with the tensile strength of the truss.

The mean practical transverse strength of a cast iron bar, one inch square and one foot in length, supported at both ends, the strain applied in the middle, is about 900 lbs.; and as the mean practical tensile strength of wrought iron is about 20,000 lbs. per square inch, the ratio between the sections of the beams and of the truss should be in the ratio of the transverse strength per square inch of the beam and of the tensile strength of the truss.

The girders under consideration are those alone in which the truss is attached to the beam at its lower flange, in which case it presents the following conditions:—

1. *When the truss runs parallel to the lower flange.*
2. *When the truss runs at an inclination to the lower flange, being depressed below its centre.*
3. *When the beam is arched upwards, and the truss runs as a chord to the curve.*

Consequently, in all these cases the section of the beam is that of an open one with a cast iron upper flange and web, and a wrought iron lower flange, increased in its resistance over a wholly cast iron beam, in proportion to the increased tensile strength of wrought iron over cast iron for equal sections of metals.

As the deductions of Fairbairn as to the initial strain proper to be given to the truss are based upon a cast iron beam with the truss inserted with the upper flange of the beam, whereby it was submitted almost wholly to a tensile strain; they will not apply to the two constructions of trussed beams under consideration. As each construction of trussed beam will produce a strain upon the truss in accordance with the position of the neutral axis of the section of the whole beam, and as the extension of the truss will vary according as it is more or less ductile, it is impracticable, in the absence of the necessary elements, to give an amount of initial strain that would be applicable as a rule.

From the various experiments made on trussed beams, it is shown:—

1. That their rigidity far exceeds that of simple beams; in some cases, it was from 7 to 8 times greater.
2. That when the truss resists rupture, the upper flange of the beam being broken by compression, there is a great gain in strength.
3. That their strength is greatly increased by the upper flange being made larger than the lower one.
4. That their strength is greater than that of a wrought iron tubular beam, containing the same area of metal.

* The elongation of cast and wrought iron being 5500 and 10,000; *hence*, 10,000 ÷ 5500 = 1·81. Fairbairn, in treating of English metals, gives the elongation as 5450 and 12,300; *hence*, 12,300 ÷ 5450 = 2·25.

(*To be continued.*)

STRENGTH OF CAST IRON AND WROUGHT IRON PILLARS.—*Continued from page 276, vol. 19.*

Tables showing the calculated breaking weight and safe weight of uniform hollow cylindrical pillars of cast iron, and the calculated weight of metal contained in each pillar.

Formula for long flexible pillars of cast iron, their length or height exceeding 30 times their external diameters, both ends of the pillars being flat and firmly fixed. $W = 44{\cdot}34 \frac{D^{3\cdot55} - d^{3\cdot55}}{L^{1\cdot7}}$ Formula for shorter pillars:— $Y = \frac{b\,c}{b + \frac{3}{4}c}$

NOTE.—The value of Y in the above formula is compounded of two quantities: *b* the strength, as obtained from the above formula for long flexible pillars; and *c* the crushing force of the material.

Hollow Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat and firmly fixed.

Length or height of Pillar in feet.	Number of diams. contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in the Pillar, in lbs.	Calculated breaking weight in tons from formula, $W = 44{\cdot}34 \frac{D^{3\cdot55} - d^{3\cdot55}}{L^{1\cdot7}}$	Safe weight in tons.
8	32	3	1½	132·32	58·41	14·60
9	36	3	1½	148·86	47·81	11·95
10	40	3	1½	165·40	39·97	9·99
11	44	3	1½	181·94	33·99	8·49
12	48	3	1½	198·48	29·31	7·32
13	52	3	1½	215·02	25·58	6·39
14	56	3	1½	231·56	22·56	5·64
15	60	3	1½	248·10	20·06	5·01
16	64	3	1½	264·64	17·97	4·49
17	68	3	1½	281·18	16·21	4·05
18	72	3	1½	297·72	14·71	3·67
19	76	3	1½	314·26	13·42	3·35
20	80	3	1½	330·81	12·30	3·07
21	84	3	1½	347·35	11·32	2·83
22	88	3	1½	363·89	10·46	2·61
23	92	3	1½	380·43	9·70	2·42
24	96	3	1½	396·97	9·02	2·25
25	100	3	1½	413·51	8·41	2·10
26	104	3	1½	430·05	7·87	1·96
27	108	3	1½	446·59	7·38	1·84
28	112	3	1½	463·13	6·94	1·73
29	116	3	1½	479·67	6·54	1·63
30	120	3	1½	496·21	6·17	1·54

Hollow Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat, and firmly fixed.

Length or height of Pillar in feet.	Number of diams. contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formula, $W = 44{\cdot}34 \frac{D^{3\cdot55} - d^{3\cdot55}}{L^{1\cdot7}}$	Calculated breaking weight in tons from formula, $Y = \frac{b\,c}{b + \frac{3}{4}c}$	Safe weight in tons.
8	19⅕	5	3½	249·94	...	212·52	53·13
9	21⅗	5	3½	281·18	...	188·80	47·20
10	24	5	3½	312·43	...	168·47	42·14
11	26⅖	5	3½	343·67	...	151·03	37·75
12	28⅘	5	3½	374·91	...	136·02	34·00
13	31⅕	5	3½	406·16	123·20	...	30·80
14	33⅗	5	3½	437·40	108·61	...	27·15
15	36	5	3½	468·64	96·59	...	24·14
16	38⅖	5	3½	499·89	86·55	...	21·63
17	40⅘	5	3½	531·13	78·08	...	19·52
18	43⅕	5	3½	562·37	70·85	...	17·71
19	45⅗	5	3½	593·62	64·62	...	16·15
20	48	5	3½	624·86	59·23	...	14·80
21	50⅖	5	3½	656·10	54·51	...	13·62
22	52⅘	5	3½	687·35	50·37	...	12·59
23	55⅕	5	3½	718·59	46·70	...	11·67
24	57⅗	5	3½	749·83	43·40	...	10·85
25	60	5	3½	781·08	40·53	...	10·13
26	62⅖	5	3½	812·32	37·91	...	9·47
27	64⅘	5	3½	843·56	35·56	...	8·89
28	67⅕	5	3½	874·80	33·43	...	8·35
29	69⅗	5	3½	906·05	31·49	...	7·87
30	72	5	3½	937·29	29·73	...	7·43

Hollow Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat and firmly fixed.

Length or height of Pillar in feet.	Number of diams. contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formula, $W = 44{\cdot}34 \frac{D^{3\cdot55} - d^{3\cdot55}}{L^{1\cdot7}}$	Calculated breaking weight in tons from formula, $Y = \frac{b\,c}{b + \frac{3}{4}c}$	Safe weight in tons.
8	24	4	2½	191·13	...	126·95	31·73
9	27	4	2½	215·02	...	110·72	27·68
10	30	4	2½	238·91	...	97·26	24·31
11	33	4	2½	262·81	83·75	...	20·93
12	36	4	2½	286·70	72·23	...	18·05
13	39	4	2½	310·59	63·04	...	15·76
14	42	4	2½	334·48	55·58	...	13·89
15	45	4	2½	358·37	49·43	...	12·35
16	48	4	2½	382·26	44·29	...	11·07
17	51	4	2½	406·16	39·95	...	9·98
18	54	4	2½	430·05	36·25	...	9·06
19	57	4	2½	453·94	33·07	...	8·26
20	60	4	2½	477·83	30·31	...	7·57
21	63	4	2½	501·72	27·89	...	6·97
22	66	4	2½	525·62	25·77	...	6·44
23	69	4	2½	549·51	23·90	...	5·97
24	72	4	2½	573·40	22·23	...	5·55
25	75	4	2½	597·29	20·74	...	5·18
26	78	4	2½	621·18	19·40	...	4·85
27	81	4	2½	645·08	18·19	...	4·54
28	84	4	2½	668·97	17·10	...	4·27
29	87	4	2½	692·86	16·11	...	4·02
30	90	4	2½	716·75	15·21	...	3·80

Hollow Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat and firmly fixed.

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8	16	6	4½	308·76	...	310·91	77·72
9	18	6	4½	347·36	...	280·61	70·15
10	20	6	4½	385·96	...	253·86	63·46
11	22	6	4½	424·55	...	230·32	57·58
12	24	6	4½	463·15	...	209·59	52·39
13	26	6	4½	501·74	...	191·35	47·83
14	28	6	4½	540·34	...	175·20	43·80
15	30	6	4½	578·94	...	161·00	40·25
16	32	6	4½	617·53	147·33	...	36·83
17	34	6	4½	656·13	132·90	...	33·22
18	36	6	4½	694·73	120·60	...	30·15
19	38	6	4½	733·32	110·01	...	27·50
20	40	6	4½	771·92	100·82	...	25·20
21	42	6	4½	810·51	92·79	...	23·19
22	44	6	4½	849·11	85·74	...	21·43
23	46	6	4½	887·71	79·50	...	19·87
24	48	6	4½	926·30	73·95	...	18·48
25	50	6	4½	964·90	68·99	...	17·24
26	52	6	4½	1003·49	64·54	...	16·13
27	54	6	4½	1042·09	60·53	...	15·13
28	56	6	4½	1080·69	56·90	...	14·22
29	58	6	4½	1119·28	53·61	...	13·40
30	60	6	4½	1157·88	50·60	...	12·65

Hollow Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat, and firmly fixed.

Length or height of Pillar in feet.	Number of diams. contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formula, $W = 44{\cdot}34 \frac{D^{3{\cdot}55} - d^{3{\cdot}55}}{L^{1{\cdot}7}}$	Calculated breaking weight in tons from formula, $Y = \frac{b\,c}{b + \frac{3}{4}c}$	Safe weight in tons.
8	$13\frac{5}{7}$	7	$5\frac{1}{2}$	367·56	...	417·76	104·44
9	$15\frac{3}{7}$	7	$5\frac{1}{2}$	413·51	...	382·08	95·52
10	$17\frac{1}{7}$	7	$5\frac{1}{2}$	459·45	...	349·79	87·44
11	$18\frac{6}{7}$	7	$5\frac{1}{2}$	505·40	...	320·71	80·17
12	$20\frac{4}{7}$	7	$5\frac{1}{2}$	551·35	...	294·61	73·65
13	$22\frac{2}{7}$	7	$5\frac{1}{2}$	597·29	...	271·20	67·80
14	24	7	$5\frac{1}{2}$	643·24	...	250·23	62·55
15	$25\frac{5}{7}$	7	$5\frac{1}{2}$	689·18	...	231·42	57·85
16	$27\frac{3}{7}$	7	$5\frac{1}{2}$	735·13	...	214·52	53·63
17	$29\frac{1}{7}$	7	$5\frac{1}{2}$	781·08	...	199·31	49·82
18	$30\frac{6}{7}$	7	$5\frac{1}{2}$	827·02	...	185·61	46·40
19	$32\frac{4}{7}$	7	$5\frac{1}{2}$	872·97	170·93	...	42·73
20	$34\frac{2}{7}$	7	$5\frac{1}{2}$	918·91	156·65	...	39·16
21	36	7	$5\frac{1}{2}$	964·86	144·18	...	36·04
22	$37\frac{6}{7}$	7	$5\frac{1}{2}$	1010·80	133·22	...	33·30
23	$39\frac{3}{7}$	7	$5\frac{1}{2}$	1056·75	123·52	...	30·88
24	$41\frac{1}{7}$	7	$5\frac{1}{2}$	1102·70	114·90	...	28·72
25	$42\frac{6}{7}$	7	$5\frac{1}{2}$	1148·64	107·20	...	26·80
26	$44\frac{4}{7}$	7	$5\frac{1}{2}$	1194·59	100·28	...	25·07
27	$46\frac{2}{7}$	7	$5\frac{1}{2}$	1240·53	94·05	...	23·51
28	48	7	$5\frac{1}{2}$	1286·48	88·41	...	22·10
29	$49\frac{5}{7}$	7	$5\frac{1}{2}$	1332·43	83·29	...	20·82
30	$51\frac{3}{7}$	7	$5\frac{1}{2}$	1378·37	78·63	...	19·65

(*To be continued.*)

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THIRTY-FIRST ANNUAL MEETING, HELD AT MANCHESTER, SEPT., 1861.

WILLIAM FAIRBAIRN, ESQ., C.E., LL.D., F.R.S., PRESIDENT.

SECTION G (MECHANICAL SCIENCE).

THE IRON-CASED SHIPS OF THE BRITISH NAVY.

BY E. J. REED, ESQ., Member and Secretary of the Inst. of Naval Architects.

The construction of iron-cased ships of war is engrossing so much of the attention of scientific men at the present moment, and is manifestly fraught with such important consequences in financial respects, that this Association could not well be expected to assemble, even in Manchester, without taking the subject into consideration.

With the view of best fulfilling the intentions with which the gentlemen of the Mechanical Section made this the chief topic of to-day's deliberations, I propose—

1st. To glance briefly at the circumstances under which the British Admiralty resorted to the construction of iron-cased sea-going ships of war.

2nd. To state as compactly as possible the principal features of the ships which the Admiralty are building and propose to build.

And 3rdly. To bring to the notice of this Association the great increase of dock accommodation which iron-cased ships have rendered necessary.

Early in 1859 the Secretary to the Admiralty, the Accountant-General of the Navy, and the Secretary and Chief-Clerk to the Treasury, together reported to the Government of the day (Lord Derby's) that France was building "*four* iron-sided ships, of which two were more than half completed," and that these ships were to take the place of line-of-battle ships for the future. "So convinced do naval men seem to be in France of the irresistible qualities of these ships," said these gentleman, "that they are of opinion that no more ships of the line will be laid down." In another part of their report they said, "The present seems a state of transition, as regards naval architecture, inducing the French Government to suspend the laying down of new ships of the line altogether." At the instance of Sir John Pakington, then First Lord of the Admiralty, this report was immediately presented to Parliament, and thus obtained universal publicity.

From that time forward, then, we have all known perfectly well what the plans of the French Government in this matter were, and have known equally well that the only mode of keeping pace even with France in the production of iron-cased ships was to lay down four of them to match the four which she at that time possessed, and to build as many more annually as she saw fit to add to her navy. In pursuance of this very simple policy, Sir John Pakington at once had designs of a formidable class of iron-cased ships prepared, and ordered the construction of one of these vessels, the *Warrior*.

The present Board of Admiralty shortly afterwards succeeded to power, and ordered a second of these vessels, the *Black Prince*, and after some delay also issued contracts for the *Defence* and *Resistance*. No other vessels of the kind was actually commenced until the present year; so that in the beginning of 1861 we had only just attained the position which France held in the beginning of 1859, having "*four* iron-sided ships, of which two were more than half completed." Meantime France had been devoting the bulk of her naval expenditure for two whole years to the production of similar vessels, and is consequently now in possession of an iron-cased fleet, far more considerable and more forward than ours.

At length, however, our sluggishness has been overcome, and we have set ourselves earnestly to work to repair our past deficiences. The *Hector* and *Valiant* have been laid down, and are being urged rapidly forward; the *Achilles*, after a year's preparation, has been fairly commenced; the *Royal Alfred*, the *Royal Oak*, the *Caledonia*, the *Ocean*, and the *Triumph* are in progress; and contracts have just been issued for the construction of three out of six other iron-cased ships, the building of which has for some time been decided upon. The peculiar features and proportions of these vessels I shall presently describe; but I will first state some of the causes which have led to delay in this matter, and set forth the circumstances under which we have at last been compelled to advance.

We have heard much in various quarters about the invention of iron-cased ships, the credit of which is usually accorded to his Imperial Majesty Napoleon III., although there are scores of persons, both here and in America, who claim it for themselves. But the truth is, very little invention has been displayed in the French iron-cased ships. Their designers have almost exclusively confined themselves to the very simple process of reducing a wooden line-of-battle ship to the height of a frigate, and replacing the weight thus removed by an iron casing $4\frac{1}{2}$ inches thick placed upon the dwarfed vessel. It was not possible to produce a very efficient ship by these means; so they have contented themselves, in most cases, with vessels like *La Gloire*, which carry their ports very near to the water when fully equipped for sea, and are characterized by other imperfections that it would be easy to point out. The reports of her efficiency which have appeared in the French newspapers prove nothing in opposition to what I here state. The writers in those papers have systematically exaggerated the qualities of the French ships for years past, representing that they could steam at impossible speeds, and carry as much fuel as any two of our ships. But these are statements which can be disposed of by scientific calculations of the most elementary kind, and the untruth of the French accounts has been so demonstrated over and over again. With the drawings and other particulars of *La Gloire* before us we could tell with the greatest precision what fuel she can stow, how fast she can steam, and at what height her ports are above the water. We have not, it is true, all the details of the ship before us yet; but we have enough to demonstrate her real qualities with sufficient accuracy for my present purpose, and I confidently assert that she is seriously defective as a war-ship in many respects.

Now, from the very first our Admiralty has been averse to the construction of such vessels as *La Gloire* and to the rough and ready solution of the iron-cased-ship problem which she embodies. Whether their aversion was wise or not, under the peculiar circumstances of the case, I shall not presume to say; but that they could speedily have produced a fleet of ships in every way equal to *La Gloire*, had they pleased, there is not the slightest doubt. Instead of doing this however, they have asked, "How do we know whether a plated wooden ship, or a plated iron ship is the better? How do we know whether the plating should extend from stem to stern, or not? How do we know whether the side should be upright or inclined? or whether the plating should be backed with wood or not? or whether it should form part of the hull or not? or whether it should be made of rolled iron or of hammered? or what its thickness should be? or how it should be fastened? and so forth. And while all these questions have been asked, we have pretty nearly stood still.

It is only fair to Sir John Pakington's Board of Admiralty to say, however, that, without waiting for answers to them, he ordered, as we have seen, the *Warrior*, which is now afloat on the Thames. Those of you who, like myself, proceeded to Greenhithe in this vessel on the 8th of August, or who have visited her there since, will doubtless concur in the praise almost universally accorded to her. In all the yacht squadrons of the country there is not a handsomer vessel than the *Warrior*; yet there are few iron-cased ships in the French Navy that will bear comparison with her as a vessel of war. She has been so often described in the public journals, and particularly in the *Cornhill Magazine* for February last, that I need not stay to describe her here.

It is also to the credit of the present Board of Admiralty, that on their accession to office, they hastened to order the *Warrior's* sister ship, the *Black Prince*, which I doubt not is in every respect her equal. But why they soon afterwards built the *Defence* and *Resistance*, ships of 280 feet in length, 54 feet broad, and 3700 tons burthen, of only 600 horse-power, and plated over less than half their length, I cannot conceive. I am aware that these vessels are primarily designed for coast defence, and that their draught of water is more favourable than *La Gloire's* for this purpose—theirs being 25 feet, and hers 27 feet 6 inches. But with engines of only 600 horse-power their speed must necessarily be low, and with so small a portion of their sides coated with thick plates they will be unfitted to stand that continued "pounding" to which a low-speed coast-defence vessel would be more exposed than a fast sea going ship. The same objections hold to a certain extent against the *Hector* and *Valiant* class, which are of the same length and very nearly the same draught of water as the *Defence* and *Resistance*; but their increased engine-power of 800 horses (which has led to an increased breadth of 2 feet 3 inches, and an increased tonnage of 360 tons) will secure for them a higher speed, and their thick plating has been continued entirely round the main deck, so as to protect the gunners throughout the length of the ship; and these, therefore, though defective, are certainly better vessels than the others.

It is important to observe that, notwithstanding the long delay of the Admiralty, and despite all we have heard respecting experimental targets, the irresistible determination of Parliament to have a large iron-cased fleet has overtaken the Admiralty before they have obtained answers to any one even of the questions which we have before mentioned, and upon which they have been so long deliberating. The cause of this is undoubtedly to be found in the indisposition of the Admiralty to perform experiments upon a sufficiently large scale. Small targets, a few feet square, have been constructed and tested in abundance; but the results thus obtained correspond to nothing that would take place in practice against a full-size ship afloat. Not a single target of sufficient size, and of good manufacture, has yet been tested. The admiralty are at length, however, having suitable structures prepared; and before long some of our principal doubts upon this subject will be resolved. Perhaps the slackness of the Board in undertaking these colossal experiments will be understood when I say that a committee of eminent private shipbuilders, including Mr. Scott Russell, Mr. Laird, Mr. Samuda, and Mr. R. Napier, have estimated that a target large enough to try half-a-dozen modes of construction would cost no less a sum than £45,000, and that another £45,000 would have to be expended upon an iron hull capable of floating this target, if the use of such a hull were considered indispensable.

But, however unprepared the Admiralty may still be, they have been compelled by the public sentiment, and by the power of Parliament, to make large additions to our iron-cased fleet during the last few months. When the House of Commons devotes immense sums of money to a national object with acclamations, and the single opponent of the measure acknowledges himself in error the time for questioning and parleying upon points of detail is past. And this is what has happened in this iron-cased ship business. The Government has declared a number of new ships necessary; Parliament has voted the requisite funds with unanimity and cheers; Mr. Lindsay has confessed himself in error; and the Board of Admiralty have been instructed to build the ships with all possible despatch. Let us now see what kind of ships they are to be.

The first of them, the *Achilles*, which has recently been begun in Chatham Dockyard, so nearly resembles the *Warrior* and *Black Prince* that a very few words will suffice for her. The chief difference between her and those vessels lies, I believe, in the fact that her beam is slightly broader, and her floor somewhat flatter, than her predecessors; whereby her tonnage is increased from 6039 to 6089 tons, and her displacement from 8625 to 9030 tons. All her other dimensions, and all her essential features of construction, are exactly like those of the *Warrior*,—from which it may be inferred that the method of plating the central part only of the ship, which was introduced by your distinguished Vice-President, Mr. Scott Russell, is still viewed with favour by the Admiralty designers. Mr. Scott Russell did not patent this invention, I believe; perhaps he will kindly tell us whether he has found his rejection of the Patent Law to pay him well in this instance.

In the class of ships which come next, however, the Admiralty have consented to forego the plan of plating amidships only, and purpose plating the ship from end to end with thick iron. But in order to do this it has been necessary to resort to larger dimensions than the *Warrior's*; and hence these six new ships, three of which have just been contracted for, are to be 20 feet longer than her, 15 inches broader, of 582 tons additional burden, and 1245 tons additional displacement. As the displacement is the true measure of the ship's actual size below the water, or of her weight, it is evident that the new ships are to be considerably more than 1000 tons larger than the *Warrior* class. As their engines are to be only of the same power, their speed will probably be less*. This diminished speed is one of the penalties which have to be paid for protecting the extremities of the ship with thick plates. Another will probably be a a great tendency to plunge and chop in a sea-way. The construction of such vessels is a series of compromises, and no one can fairly blame the Admiralty for building vessels on various plans, so that their relative merits may be practically tested.

The cost of this new class of ships will exceed that of the *Warrior* class by many thousands of pounds, owing to the increased size. But it will certainly be a noble specimen of a war-ship. A vessel built throughout of iron, 400 feet long and nearly 60 broad, invulnerable from end to end to all shell and to nearly all shot, armed with an abundance of the most powerful ordnance, with ports 9 feet 6 inches above the water, and steaming at a speed of, say, 13 knots per hour. will indeed be a formidable engine of war. And, if the present intentions of the Admiralty are carried out, we shall add six such vessels to our Navy during the next year or two. We must be prepared, however, to dispense with all beautifying devices in these ships. Their stems are to be upright, or very nearly so, and without the forward-reaching "knee of the head" which adds so much as the beauty of our present vessels. Their sterns will also be upright, and left as devoid of adornment as the bows. It should also be stated, as a characteristic feature of these six new ships, that their thick plating will not extend quite to the bow at the upper part, but will stop at its junction with a tranverse plated bulkhead some little distance from the stem, and this bulkhead will rise to a sufficient height to protect the spar deck from being raked by shot.

It has not yet been decided whether these new iron ships are to have their plating backed up with teak timber, as in the previous ships; or whether plating 6½ inches in thickness, without a wood backing, is to be applied to them. The determination of this point is to be dependent, I believe, upon the results of the forthcoming experiments with the large targets to which I have previously adverted, and partly upon the recommendations of the Iron Plate Committee, to which our President belongs, and which is presided over by the distinguished officer now present, Captain Sir John Dalrymple Hay, R.N. All that has been decided is, that whether the armour be of iron alone or of iron and wood combined, its weight is to be equivalent to that of iron 6½ inches thick. The designs of the ship have been prepared subject to this arrangement, and provision has been made in the contracts for the adoption of whichever form of armour may be deemed best when the times comes for applying it.

All the iron-cased ships which I have thus far described are built, or to be built, of iron throughout, except in so far as the timber backing of the plates, the planking of the decks, and certain internal fittings may be concerned. I now come to notice a very different class of vessel, in which the hull is to be formed mainly of timber, the armour plating being brought upon the ordinary outside planking. The *Royal Alfred*, *Royal Oak*, *Caledonia*, *Ocean*, and *Triumph* are to be of this class. Their dimensions are to be—length 273 feet, breadth 58 feet 5 inches, depth in hold 19 feet 10 inches, mean draught of water 25 feet 9 inches, and height of port 7 feet. They are to be of 4045 tons burthen and to have a displacement of 6839 tons. They are to be fitted with engines of 1000 horse-power. They are being framed with timbers originally designed for wooden line-of-battle ships, but are to be 18 feet longer than those ships were to be. They will form a class of vessels intermediate between the *Hector* and the *Warrior* classes, but, unlike both of them, will be plated with armour from end to end. They will be without knees of the head, and with upright sterns; and will therefore look very nearly as ugly as *La Gloire*, although in other respects much superior vessels, being 21 feet 6 inches longer, 3 feet 5 inches broader, and of less draught of water. They will also be quite equal to her in speed.

It will occur to some now present, that in adopting this class of ship, we have, after three years' delay, approximated somewhat to the *Gloire* model at last. And undoubtedly we have done so in the present emergency, in order to compete with the movements which France is now making. At the same time we have not gone to work quite so clumsily as our neighbours. Instead of retaining the old line-of-battle ship proportions, we have gone somewhat beyond them; and have lifted all the decks, in order to raise our guns higher above the water. We have consequently secured a height of port or battery nearly 18 inches greater than *La Gloire's*—an advantage which will prove valuable under all ordinary circumstances, and incalculably beneficial in rough weather.

The whole of the new iron-cased ships, including the five plated timber ships and the six 400-feet iron ships, will, there is every reason to believe, match *La Gloire* in speed, supposing the engines put in them to be of the respective powers already mentioned—a condition which it is necessary to state, since there is, I regret to say, a probability of smaller engines being placed in some of them. But not one of all these new ships, the *Achilles* only excepted, will have a speed equal to the *Warrior's*. Perhaps we ought not to complain if our fleets are as fast as the French; but I, for one, certainly do regret that there should be any falling off in this prime quality of our iron-cased vessels. Iron and coal will give us fast vessels; and we have these in abundance. The truly admirable engines which Messrs. Penn have placed in the *Warrior* show that we can command any amount of engine-power that we require, without incurring risk of any kind; and it would indeed be a blind policy to deprive ourselves of that speed which is pronounced invaluable by every naval officer and man of science who writes or speaks upon this subject.

I have thus far said nothing concerning the armaments of the new classes of vessels which I have been describing, because nothing has yet been finally decided respecting them. Nor would it be wise to decide this matter in the present state of our artillery, until to do so becomes absolutely necessary. We are, it is said, producing 100-pounder, and even larger, Armstrong guns with great success now, and may therefore hope for supplies of ordnance of at least that class for these vessels; but the modifications and improvements which even Sir William Armstrong himself has introduced since he became our engineer-in-chief for rifled ordnance, have been so great that we have lost all confidence in the continuance of existing systems, and hold ourselves prepared daily for further changes. Before these new ships are fit to receive their armaments, or even before they have so far progressed as to make it necessary to fix the positions and dimensions of their ports, we may be put in possession of a far more effective naval gun than we can yet manufacture; and the best gun, wherever it may come from, must unquestionably be adopted for them. Whoever may produce it, we shall have, let us hope, the great benefit of Sir William Armstrong's splendid mechanical genius, and large experience, in manufacturing it in quantity at Woolwich. This is an advantage which should not be thought lightly of; for, whatever other views some may entertain, either through jealousy, or rivalry, or conscientious conviction, we must all agree in believing it a great piece of good fortune to have one of our very ablest mechanicians placed at the head of this great mechanical department.

I am able, however, to afford some information respecting the number of guns which the various classes of our new ships will be able to carry, and probably will carry. Of the *Defence*, *Resistance*, *Hector*, and *Valiant* I shall say nothing, because they cannot be considered fit for the line-of-battle, or suitable for any other service than coast defence. Nor need I say more of the *Achilles* than that she will in all probability be armed with such ordnance as may be found to answer best in the *Warrior* and *Black Prince*. We come, then, to the plated timber ships; and these I may usefully compare with the model French vessel. We know that *La Gloire*, which is 252 feet 6 inches long, has an armament of 34 guns upon her main deck, and two heavy shell-guns besides—36 guns in all. Now our ships are to be more than 20 feet longer than her, and will therefore take two additional guns on either side; so that they will carry not less than 40 guns, if the ports are placed as close together as in *La Gloire*. I need claim no greater advantage for them in respect of their armaments; but they are manifestly entitled to this. As a matter of fact, however, they will probably have a much more powerful armament. It is proposed, I believe, to arm them with about as many guns as *La Gloire* on the main deck, all 100-pounder Armstrong's, and 16 or 18 other guns, principally Armstrong's, on the upper deck, making about 50 guns in all. If this intention be carried out, they will manifestly be much more powerful vessels than the original French ship. The newest and largest vessels, those of 400 feet in length, will each carry at least 40 Armstrong 100-pounders on the main deck, which will be cased with armour, as I before stated, from end to end. In addition to these they will doubtless

*Since this paper was read at Manchester, I have learnt that the Comptroller of the Navy always intended these vessels to have a speed of 14 knots, and will give them sufficiently powerful engines to secure that, if possible.—E.J.R.

have powerful ordnance on their upper decks, for use under favourable circumstances. But all these arrangements are, I repeat, liable to change*.

Unfortunately, I am unable to compare the power of these vessels with that of the largest of the French iron-cased ships, owing to the absence of all detailed information concerning them. I trust, however, that the Admiralty are in possession of the necessary particulars, so that the delay which has taken place may be turned to the best possible account by securing superiority for our fleet. If this be so, then we shall, after all, profit by the apparent sluggishness of our naval authorities. In fact, if England had France only to consider, and if the Government of England were embodied in a single sagacious ruler as absolutely as is that of France, so that we could ensure prompt action in an emergency, the very best course for us to pursue in this great naval competition would be to leave the lead in the hands of the French Emperor, taking care to add a ship to our Navy for every one added to his, and to make ours much more powerful than his. In the event of war, our manufacturing resources would be abundantly sufficient to secure for us a further and almost instant preponderance. the game which we should thus play would be both politic and economical. But with other naval nations to compete with, and with the inertia which inevitably, and often happily, attends a constitutional and parliamentary system of government, we cannot afford to play games of skill with omnipotent emperors, but are bound to be ever ready to assert our pre-eminence.

I have a little information concerning the *Solferino* and her sister French ships which it may be useful to give you. Her length is 282 feet, breadth 54 feet, mean draught of water 26 feet, displacement 6820 tons, thickness of armour plating $4\frac{3}{4}$ inches, nominal horse-power of engines 1000. Her plating extends from stem to stern over the lower gun-deck, and rises up amidships sufficiently high to cover two decks. She is furnished with an angular projection or prow below the water, for forcing in the side of an enemy when employed as a ram. I regret my inability to add materially to these details of the largest French ships.

Let me now consider briefly the pecuniary phase of this iron-cased ship question. We may fairly assume that the average cost of such vessels will not be less than £50 per ton, and that their engines will cost at least £60 per horse-power. Supposing these figures to be correct, then the hulls of the eighteen ships which we have been considering will cost us £4,681,600, and their engines £1,143,000—together nearly *six millions* pounds sterling. When masted, rigged, armed, and fully equipped for sea, they will of course represent a much larger sum—probably nearly *eight millions.* These estimates will afford some faint conception of the nature of that "reconstruction" of the Navy upon which we may now be said to have fairly entered, in so far as the ships themselves are considered.

But I must not conceal the fact that the introduction of these enormous iron-cased ships has entailed upon us the construction of other colossal and most costly works. We have now to provide immense docks for their reception; for we at present possess none suitable to receive them. Nor must these docks be of large proportions only; for in order to sustain ships burdened with thousands of tons of armour, they must be furnished with more substantial foundations and walls than any hitherto constructed, and be built of the best materials and with the soundest and firmest workmanship.

Many considerations combine to exalt the importance of this part of my subject. In the first place, the tendency which iron ships have to get foul below water will render it necessary to dock our new ships frequently, under ordinary circumstances, and whether we go to war or not. In the second place, for aught we yet know, these ships may be found to give signs of local weakness as soon as they are taken on an ocean cruise, and to require such repairs and strengthenings as can only be performed in dock. Again, being steamships, they will be continually liable to accidents in connection with the engines or the propelling apparatus; and with many such accidents docking will become indispensable. And so I might proceed to multiply examples of this kind. But there is one consideration which is paramount, and which may therefore be stated at once; we dare not send these ships against a French fleet unless we have docks for them to run to in the event of a disaster. We know not what may happen to these altogether novel structures until they have been exposed to successive broadsides from a heavy naval battery; and it would be madness to send them out to encounter a powerful fleet of vessels as strong as themselves unless we are prepared to open docks to receive them in case of necessity.

I have said that we are at present without dock accommodation for these ships; and it may be desirable to illustrate the correctness of this statement in detail. What we require for them in each case is, first, deep water up to the entrance of the dock; secondly, a depth of not less than 27 or 28ft. of water over the sill of the dock; and thirdly, a length on the floor of the dock of 400ft. Now, these three conditions are not combined, I believe, in any dock in Great Britain—certainly not in any of Her Majesty's Dockyards. At Portsmouth we have just completed a pair of docks which can be thrown into one, 612ft. long. But over the bar of Portsmouth harbour there is a depth of 17ft. only at low water, 27ft. at high water *neaps*, and 30ft. at high water *springs.* Consequently, these large iron-cased ships, if they went to Portsmouth in a dangerous state, or in hot haste to get to sea again, would nevertheless have to wait for the very top of the tide before they could get either in or out. But even if there were no bar, the Portsmouth dock would still be unavailable in such an emergency; for the depth of water over the sill of one portion of it is but 25ft. at high-water springs. It is into this dock that the *Warrior* is shortly to be taken for the purpose of having her launching cleats removed, and her bottom cleaned. As she can at present afford to wait upon the tide without inconvenience, there will be no difficulty in this case. But in war time it would never do to keep such an important member of your squadron fretting for the tide at Spithead, or to have to lighten her before she could cross the dock's sill. At Devonport, again, the longest dock is only 299ft. long over all; but I am happy to state that one is in progress of construction 437ft. long, 73ft. broad, and 32ft. deep at the sill. At Keyham, the longest dock (the South), which is 356ft. in length, has but 23ft. depth at the sill. while the North, which has 27ft., is but 308ft. long. At Pembroke, there is a dock of 404ft., but it has a sill of 24ft. 6in. only. The longest dock at Sheerness is 280ft.; at Woolwich, 290ft.; and at Chatham, 387ft., but the last has but 23ft. 6in. at the sill. At Deptford there are but two docks, opening into one, and they are very shallow. There are a few large private docks in the country which come very near to our requirements. There is the Canada Dock at Liverpool, for example, 501ft. long, 100ft. broad, and with 25ft. 9in. over the sill. There are also No. 1 Dock at Southampton, and the Millbay Dock near Plymouth, of which the former is 400ft. long, with 25ft. over the sill, and the latter 367ft., with 27ft. 6in. over sill. But none of these answer all our requirements, nor could we avail ourselves of more than one or two of them in time of war if they did.

If we turn to the French coast, we shall find that in this matter also we are far behind our neighbours. At Cherbourg there are two docks 490ft. long, and 80ft. broad; two 380ft. by 70ft.; two 350ft. by 65ft.; and two smaller ones besides. At Brest, again, there is building a double dock 720ft. by 90ft.; and there are also two 492ft. by 60ft., and two smaller. At L'Orient there is one 350ft. long, and another (building) 500ft. At Toulon there are two in progress, one 406ft. long, and the other 588ft., besides several smaller docks which have existed for some time. I cannot give the depth of the sills of any of these French docks, for I have been unable to obtain that element in any single case even; and I am assured that no account of it is anywhere recorded in this country. But there is no good reason to doubt that a proper depth has been given in most instances.

You will now be able to comprehend the advantage which France has secured in this matter of dock accommodation for her iron-cased fleets, and will readily discern the danger to which we should be exposed in the event of an early war with that country. A single action might so seriously cripple both fleets as to renders large repairs necessary; but France alone would be capable of renewing her strength. It would be our lot to lie crippled in our harbours, while she captured our commercial vessels and menaced our coasts.

I am perfectly well aware that a large increase of dock accommodation is to be supplied at Chatham forthwith. But our Channel and Mediterranean fleets must not depend upon docks at Chatham, which cannot be reached from the south until a long passage has been made, the Nore sands threaded, and an intricate and shallow river navigated. We must give to our ships the advantage which Cherbourg secures for the French, and which they propose to augment by establishing at Lezardrieux* an immense steam arsenal, protected by an impregnable series of defences.

It will now be seen that, in order to place ourselves upon an equality with the French Navy, no less than to meet the certain emergencies which must arise with our reconstructed fleets, we ought without delay to found a colossal dock establishment on some favourable point of our southern shores, furnished with the means of carrying on extensive repairs in time of war. The most suitable of all positions is probably that of the Southampton Water, the shore of which, at the entrance to the river Hamble, presents conditions and circumstances which finely qualify it for the purpose. If we are wise enough to build a set of suitable docks there before the time of war arrives, we shall have the satisfaction of knowing that the largest iron-cased ships now in contemplation will be able to run in and be docked with all their stores on board, and everything standing. And nothing less than this should satisfy us.

INSTITUTION OF CIVIL ENGINEERS.

December 17, 1861.

GEORGE P. BIDDER, Esq., President, in the Chair.

ANNUAL GENERAL MEETING.

Before commencing the proceedings the President said, that under ordinary circumstances he should have suggested to the members the propriety of adjourning the meeting, in order to testify their regret for the lamented decease of their honorary member H.R.H. the Prince Consort, and their deep sympathy with their beloved Sovereign and the Royal Family on their bereavement. As, however, the Charter imperatively demanded the election of the Council and Officers on that evening, the Council did not feel authorised in postponing the meeting, which would be restricted to the mere routine of the election.

In presenting an account of the proceedings of the Institution during the last twelve months, to which the report was exclusively devoted, it was stated that they would contrast favourably with those of any previous year. The more than ordinary attendances at the meetings showed, that the subjects brought forward for discussion had equalled, even if they had not exceeded, in interest those of former sessions. The elections of members and associates had been as numerous, and as a consequence the abstract of accounts exhibited a very satisfactory result. Considerable additions had been made to the library, to which the attention of a special Committee of the Council had been closely directed.

The principal "papers" read during the session were then noticed; and it was remarked that many important works, some involing considerable novelty, had been executed by members of the Institution, both at home and abroad, which

* Since this paper was read, the issue of 100-pounder Armstrongs has been suspended —E.J.R.

* See an admirable article in Capt. Becher's *Nautical Magazine* for July, 1861.—E.J.R.

had never been described. It was, therefore, desirable, that every acting and resident engineer, on the completion of any undertaking upon which he might have been engaged, should prepare a descriptive narrative of the progress of the works, of any peculiarities in their design, and particularly of any incidents that might have occurred during their construction.

With a view to encourage the production of really valuable original communications, in preparing the list of subjects for premiums for the session 1861-62, it was determined to offer pecuniary awards not exceeding in amount twenty-five guineas each, in addition to the honorary premiums, for a limited number of papers of distinguished merit. Although five subjects had been specially selected, it was stated that other essays would be considered, if of adequate merit. It was hoped that this would have the effect of inducing the presentation of many useful papers, not so much from the intrinsic value of the reward, as from the distinction it would confer on a successful competitor.

With regard to the library, it was stated that the application to the Lords of the Treasury for copies of the Ordnance and Geological Maps of the United Kingdom had not been successful; the reason assigned being, that their gratuitous supply had been discontinued in 1850, on the recommendation of the late Board of Ordnance, and that the Institution of Civil Engineers could not be made an exception to the rule. No steps had been taken for their purchase, as, for the same sum, many books, atlases and general maps could be obtained, which were likely to be more generally useful. The purchases already made included library maps of Europe (topographical and geological), of England, Scotland, Ireland, India, the United States, and Canada; and spaces had been left for maps of the world and of Asia to be added, as soon as the new editions now in hand were completed. Two comprehensive atlases, and a few standard French and English works, especially to complete series hitherto imperfect, had also been purchased. Much useful information had been procured, particularly from the continent, which would facilitate future purchases. Thus, there had been obtained, from the Ecole des Ponts et Chaussées a carefully prepared catalogue of works recommended by that School; from the Royal Institution of Engineers of Holland a marked list of the best books on water construction; and it was hoped that similar particulars would be shortly received from Germany and Italy. It was on all accounts desirable that the library should be unrivalled in its peculiar specialty; that it should contain copies of all treatises on engineering and the allied sciences, wherever published; and the co-operation of the members generally was earnestly solicited, to enable this to be accomplished.

The abstract of the accounts showed, that the amount received from subscriptions and fees was greater than in any previous year, and that the current subscriptions were now 50 per cent. in excess of what they were in 1851. During the year the Stephenson and the Miller bequests had been invested in railway debenture stocks, and an addition of £900 had been made to the Institution fund, so that the total investments now amounted to £12,194 12*s.* 11*d.* The sums on deposit at the Union Bank, and the current balance at the bankers', raised this amount to nearly £15,000.

The amount of arrears of subscription due for 1861 was £241 10*s.*, and for 1859 and 1860, £89 5*s.*; together, £330 15*s.* Great exertions had been made to reduce the sums owing for previous years, and in some cases the arrears had been paid in full, while in others a composition had been made. But still the Council had been under the painful necessity, "after suitable remonstrances," of erasing the names of one member, nineteen associates, and two graduates from the register.

The decease during the year were announced to have been: Mr. Eaton Hodgkinson and General Sir Charles William Pasley, honorary members; Sir William Cubitt, Messrs. William Allcard, Samuel Clegg, Nicholas Harvey, Joseph Maudslay, John McVeagh, John Plews, James Ralph Walker, and John Ward, members; Colonel Robert Kearsley Dawson, R.E., C.B., Messrs. George Aitchison, James Braidwood, Charles Frederick Cheffins, Octavius Cockayne, Charles Cowper, Henry Alcock Fletcher, Lionel Gisborne, William Newton, John Pigott Smith, Edmund Treherne, and John Neville Warren, Associates.

The number of elections had been 69, of decease 23, of resignations 9, and of erasures 22, so that the effective increase of the year was 15, making the total number of members of all classes 945. It was mentioned that within the last quarter of a century the number of members of all classes had increased nearly four-fold.

In closing the report, the Council urged that the success of the Institution depended a great deal more upon the individual exertions of the members, in support of its scientific character, than upon its pecuniary prosperity; and that it could not continue to hold the high position it had already attained, without efforts and sacrifices being made by the present members, similar to those which were so unremittingly and so freely incurred by their predecessors.

After the reading of the report, Telford medals were presented to Messrs. W. H. Preece, G. P. Bidder, junior; and F. Fox; Council premiums of books to Messrs. W. H. Preece, F. Braithwaite, G. Hurwood, and W. Hall; and the Manby premium, in books, to Mr. G. P. Bidder, junior.

The following gentlemen were elected to fill the several offices on the Council for the ensuing year:—John Hawkshaw, President; J. E. Errington, J. Fowler, C. H. Gregory, and J. R. McClean, Vice-President; Sir William Armstrong, J. Cubitt, T. E. Harrison, T. Hawksley, G. W. Hemans, J. Murray, J. S. Russell, G. R. Stephenson, C. Vignoles, and J. Whitworth, Members; and Mr. John Cochrane, and Col. Simmons, R.E., Associates.

ADDRESS OF JOHN HAWKSHAW, Esq., F.R.S.,

ON TAKING THE CHAIR FOR THE FIRST TIME AFTER HIS ELECTION AS PRESIDENT, JAN. 14, 1862.

GENTLEMEN,—I beg to thank you for the honour you have done me, in electing me to the office of President of this Institution.

In undertaking the important duties it involves, I can safely promise not to fail in their discharge from any want of interest in your proceedings, nor from any lack of zeal for the advancement of the objects of the Institution.

The profession of which we are members has from my earliest days been an object of attachment to me, and were I actuated by no other motives, the love I bear to it would prevent me becoming lukewarm to its interests. For my deficiences, I trust to your forbearance, and rely on the help of the many friends I see around me.

It is important to notice at the outset, that the wide range of subjects which the profession of a Civil Engineer embraces, renders it imperative on every member of it to avail himself of all the help he can obtain. He requires the assistance of many departments of science and art, and must call into employment important branches of manufacture. He can perform no great work without the aid of a great variety of workmen, and it is on their strength and skill, as well as on their scientific direction that the perfection of his work will depend. The personal experience of one individual cannot fit him for the exigencies of a profession which is ever extending its range of subjects, and is constantly dealing with new and complex phenomena; phenomena, which are all the more difficult to deal with from the fact, that they are generally surrounded by such variable circumstances as render them incapable of being submitted to precise measurement and calculation, or of being made amenable to the deductions of exact science. Consequently nothing is more certain than that he who wishes to reach the perfection of his art must avail himself of the experience of others, as well as of his own, and that he will not unfrequently find the sum of the whole little enough to guide him.

And let no inventive genius suppose that his own tendencies or capabilities relieve him from this necessity.

There is, I believe, no such thing as discovery and invention, in the sense which is sometimes attached to the words. Men do not suddenly discover new worlds, or invent new machines, or find new metals. Some indeed may be, and are, better fitted than others for such purposes, but the process of discovery is, and always has been, much the same. There is nothing really worth having that man has obtained that has not been the result of a combined and gradual process of investigation. A gifted individual comes across some old footmark, stumbles on a chain of previous research and inquiry. He meets, for instance, with a machine, the result of much previous labour; he modifies it, pull it to pieces, constructs, and reconstructs it, and by further trial and experiment, he arrives at the long-sought-for result.

While, however, it is necessary, if our progress is to be safe, that we should proceed with due caution, it is exhilarating to notice, that in the matters to which our profession relates, progress is more apparent than it is in most other pursuits.

The great range of objects which it embraces, and which seems ever extending, partly, no doubt, accounts for this.

We are called upon to construct the great highways of nations, and to build the steamboats that bridge the seas. We make the machines by which man seeks to lighten labour and to accumulate force, or to give to that force new directions. We build docks, harbours, and lighthouses, to receive, shelter, and warn the mariner; and, as if in contrast to works so useful and so humane, some of us are occupied in the warlike objects of defence and destruction. And at this day, young members can look back far enough to distinguish the rapid progress that has been made in those matters to which the civil engineer has to devote his attention.

Thus, it is hardly thirty years since travelling began to be transferred from common roads to railways. In the comparatively short period that has since elapsed, in a less space of time than one generation of man, about seventy thousand miles of railway have been made in different countries, at an outlay of about eleven hundred millions of pounds sterling, and involving an amount of engineering works exceeding in magnitude and importance all the previous engineering works of the world put together.

In effecting this great change, English engineers have taken a prominent part, about one-half of the vast outlay above referred to having been expended under their direction; and they may, I think, feel a pardonable pride in the great works which they have helped to construct, and which are destined to produce an amount of beneficial change and advancement in the habits and culture of mankind, which the most sanguine man of the present day will probably fail fully to estimate.

Simultaneously with this change and tending to the same ends, there has been the improvment of steam navigation. I crossed the Atlantic in 1835, in what was then considered one of the swiftest packets; but in those days the Atlantic packets depended wholly on sails, and the voyage occupied twenty days. Many years have not elapsed since it was denied that steamers could cross the Atlantic at all. They do so now in nine days. The progress that has been made in steam navigation in the last few years is truly remarkable. The steamboats plying between Holyhead and Dublin, which were then, as now, among the fastest afloat, had, ten years ago, attained a speed of seventeen miles an hour. Last year those boats were superseded by others—the *Leinster*, *Munster*, *Connaught*, and *Ulster*—which attained on their trial trip a speed of twenty miles and a half an hour.

Great progress has also been made in the application of the screw-propeller to steamships, which, for vessels of war, and other purposes, possesses advantages over the paddle, though it has not hitherto accomplished an equal speed.

In 1848, the fastest screw line-of-battle ship in the navy could not steam more than about seven and a half knots, or eight miles and two-thirds per hour, whereas, the *Warrior*, though clothed with an outer coat of iron armour four inches and a half thick, at her trial in October last over the measured mile in Stokes Bay, attained an average speed of 14·356 knots, or 16·533 miles per hour, beating the *Howe*, which previously had attained the highest trial speed of any of Her Majesty's line-of-battle ships; the displacement, power, and speed of the two ships being as follows:—

Name.	Displacement.	Indicated Horse Power.	Speed per hour.	
			Knots.	Miles.
Warrior	8852	5469	14·356	16·533
Howe	4770	4523	13·565	15·623

Since 1848 the speed of this class of ships has been nearly doubled. The build and construction of steamboats has also, during the same period, received much attention, and been greatly improved.

The doubts which prevailed until very lately, whether iron was the best material for line-of-battle ships, seem now nearly dispelled, although the rapidity with which iron fouls will, unless some remedy can be devised, always be a source of trouble.

The precise and best mode of constructing iron ships of war is still an interesting problem; and many improvements may still be expected in an art which is yet in its infancy.

Hitherto a large amount of wood has been combined with the iron. The *Warrior* has a thick lining of timber between the inner skin and the outer armour-plates. A material so soft as wood can hardly increase the capability to resist shot; and there seems great difficulty in combining, to any good purpose, two materials differing so much in strength and density. Besides which, wood rots, and is, in ships especially, a perishable material. The probability is that iron will supersede the use of wood in a still greater degree, and that, by the adoption of improved modes of construction, the whole of the iron used in the structure of ships of war will be made to add to the strength of the ship, as well as be useful for its defence. This is not the case in the present mode of construction. The armour-plates of the *Warrior* add very little to the strength of that ship. There seems to be no good reason why the upper and lower decks, and every portion of the hull of such vessels, should not be of iron. Greater strength would be thereby attained to resist diagonal and cross strains, and much greater longitudinal stiffness would be secured. Ships of war should be constructed practically, as far as it is possible, as if welded out of one piece of iron; and if they are ever to be used as rams, this mode must be adopted, for it is evident that the present methods of construction would be quite unsuited for such a purpose.

That war steamers and other steamships can be made stronger, and may be made to steam faster than they yet have been, there is no doubt. No one can have taken the trouble to examine the present methods of building without seeing that it is easy to increase their strength without impairing their efficiency in other respects.

With regard to the speed we ought to obtain, it is with steamers as with locomotive engines, a question just now of what velocity we can afford to pay for, rather than of what rapidity we can physically attain. There is no doubt that the speed of either could be accelerated beyond any point yet reached, and probably beyond any point that the nation at present could afford.

The speed of steamboats and of railroads will have to be determined from time to time, and will vary with circumstances, with place and time, with the accumulation and distribution of wealth.

For cost after all greatly, if not rigidly, regulates progress, whether it relate to civil, to military, or to naval affairs. A hundred years ago no nation could have afforded railways of fifty miles an hour, nor steam-boats of twenty miles an hour. The reasons for this are obvious, though often overlooked. Passengers, for instance, can afford a higher rate of speed than goods and minerals; and some descriptions of merchandize require to travel faster than stone, coals, &c. Again, some passengers can better afford to pay for speed than others. Even now it is on certain lines only that there are a sufficient number of passengers who are able to pay for express-trains, and where, consequently, the appointment of such trains can alone be justified. We have not yet, as it respects steamers (except for short distances), secured an equal amount of passenger traffic; and until this be the case, they must be built and worked for passengers and cargo. Moreover, wherever time is an element of importance, the exigencies of trade and the convenience of the public require frequent opportunities of travelling and of transport from place to place. This circumstance determines the number of passengers and weight of goods to be conveyed each journey from each place, and, combined with other circumstances, establishes a law which, for the time being, regulates the load on every railway, in every steam-boat, and along each line of communication. Thus, large and powerful as locomotive engines have become, they convey on the London and North-Western and Great Northern Railways an average load of less than 70 tons of merchandize; and though the Lancashire and Yorkshire Railway has a larger mileage of merchandize traffic than either, the average load, owing to the close proximity of towns, and the greater necessity for frequent trains, is only about 45 tons. The same principle applies to steamboat traffic. Again, however superior for naval warfare a steam line-of-battle ship may be to one with sails, yet England, rich as she is, could not at the present day undertake to support a navy which should wholly dispense with the use of sails, which should move to and from, and among her distant dependencies by the power of steam alone, and which, consequently, would always be dependent upon, and therefore would always require to be supplied with a sufficiency of fuel.

With respect to the speed of railways, there is at present an anomaly, which, before long, will require more attention than at present has been bestowed upon it. Thus, to make way for passenger trains, goods and mineral trains, which might move more slowly, are, in many cases, hurried on, manifestly to the prevention of due economy.

Besides, though I deem it possible that railways ultimately will be made for greater speeds than those at present adopted, I am of opinion that on some lines the companies have attained a rate of travelling which is in advance of their appointments in other respects,—such as with the condition of their road, and with the state of their finances. Railway companies already feel that great speed demands larger expenditure upon their permanent way—their rolling stock—for telegraphic signalling—and for other matters, without which the continuance of such speed becomes positively unsafe: and if the whole of the expenditure which great speed thus entails upon companies were fairly met, it is questionable whether the present speed of railways is not now, in many cases, fully greater than can be afforded.

Goods and minerals, on busy lines, are, there can be no doubt, carried at a speed which is neither demanded by the public nor is economical to the company; but which is often rendered unavoidable from the necessity of keeping out of the way of swift passenger trains, and by the difficulty of interpolating goods and mineral trains among the frequent trains of a large passenger traffic.

But is there no remedy for this? The travelling public demand from railway companies the highest rate of speed they can exact; and that, as I have observed, is sometimes greater than the state of the road and other matters warrant. Would any good result from the introduction of Government interference to regulate speed? I think not. Such a measure might strike at the root of improvement, and the evil is one which will work its own cure, and for which a remedy may be provided in different ways.

It has been urged that the time of travelling between two points may be shortened as well by diminishing stoppages as by an increase of speed. But this mode of dealing with it again becomes a question of cost; for if local traffic is not to be neglected, diminishing the number of stoppages involves more trains more expense therefore, and the difficulty of applying this remedy will increase with the growth of traffic.

It may have to be met, in certain cases, by constructing lines to carry goods and minerals only, at a slow speed; and ultimately, perhaps, in other cases, at some future day, by making railways to carry passengers mainly, if not solely.

In grouping engineering works we may class the electric telegraph with railways and steamboats. All three are agents of intercommunication, and tend to the same important ends. And while the vast importance of each cannot be overrated, the electric telegraph is, perhaps, in the peculiarity of its operation, the most wonderful of all.

It was about the same time that the Liverpool and Manchester Railway was started that the minds of a few individuals were first devoted to the subject of using electricity as a medium of communication for messages.

Messrs. Cooke and Wheatstone's patents were taken out in 1837, but the first public telegraph was not established till 1839, when a communication was made by wire on the Great Western Railway between London and Slough.

Since that period, in this country alone, telegraphic communication has been extended over about 14,500 miles; in the rest of Europe, over about 100,000 miles; in the American States, over about 48,000 miles; and the total extent of telegraph at this moment cannot be less than 200,000 miles.

On land, this most useful discovery has been uniformly successful. Like railways, it has grown (in England, by public support alone) into a great institution.

Ocean telegraphy has been less fortunate in its results. Short lines across the narrow seas have been laid and maintained, but at a serious amount of cost.

To some extent, no doubt, the failure of deep-sea telegraphs may be attributed to ill-conceived arrangements, and to faulty designs and workmanship; but the very nature of such an undertaking as laying telegraph wires across the Atlantic precludes the possibility of acting on previously-acquired experience, and makes the requisite experimental trial one of serious cost.

The labours of the late Commission appointed to inquire into this subject have made the necessary scientific conditions for forming a good ocean cable better, and perhaps sufficiently, understood. But they leave the ultimate cost of maintaining a permanent and available communication across three thousand miles of ocean (as, in fact, the great attendant contingencies compelled them to leave it) a question for the future to decide.

A communication with America once well established, would call for numerous wires. To meet contingencies, risk of accidents, and stoppages, a single cable would hardly be sufficient. With ample provision in these respects, a communication between the two countries could be maintained, but at a cost not at present admitting of calculation. There are some things physically practicable, but which in a commercial and monetary sense are for a while unattainable, and the accomplishment of this great object may therefore be delayed. It is to be hoped, however, that it will not be finally abandoned.

Simultaneously with the rapid advance which has been made in the works to which I have referred, there has also been great progress in another branch of engineering with which Civil Engineers have latterly become connected.

That new branch is gunnery. In a very few years, mainly in consequence of the labours of Sir William Armstrong and of Mr. Whitworth, the range of artillery has been doubled. The weight of the gun in proportion to that of the projectile has been reduced to one-half, and the capacity for powder of the elongated as compared with the round shell has been more than doubled. This great advance in the destructive power of cannon has rendered most of our old fortifications useless. New fortifications have therefore to be built, adapted to the longer range and greater destructive power of the new artillery. These fortifications require to be placed more in advance of the places to be defended, and to be constructed with very superior powers of resistance to those which hitherto have proved sufficient. The old walled towns, which were formidable enough in former days, would to day, in case of a siege, afford little security to the inhabitants who dwell within them; the old defences, therefore, have be removed, and replaced, where necessary, with those more suitable to modern requirements.

We are clothing our ships of war in iron mail, and it seems probable that iron in some cases will be largely used in modern fortifications. Not that earthwork and stonework will cease to be useful. These are valuable for the staple of most forts, but neither of them make good embrasures, and for that purpose iron offers great advantages. By its use greater strength can be secured at those points where power of resistance is specially wanted. By its use also the size, and consequently the exposure, of the embrasures will be diminished, and much greater facility be given for working the guns and training them through larger angles.

There are some cases, however, in which forts may with advantage be principally, if not wholly, built of iron. I hope to see that material adopted for the superstructure of the large sea-forts at Spithead, the construction of the foundations for which has been intrusted to me. There can, I think, be no insuperable difficulty in constructing iron forts so as to be impregnable to a ship's battery, though in the absence of knowledge as to what may be the ultimate powers of guns, it is not easy at present to arrive at safe conclusions. The difficulty of doing the converse of this, viz., of building ships so as to be impregnable to the fire of such artillery as may and ought to be placed in the new forts will be a problem not so easily solved.

No plated ship yet built could keep afloat under the fire of guns throwing shots of 200 to 300lbs. weight; and it seems difficult, in the case of ships which require buoyancy, sufficiently to increase the thickness of their armour-plates to keep pace with the probable advance in weight and size of the new cannon.

Naval commanders rely a good deal, and perhaps up to a certain point correctly so, on the mobility of their ships; but ships cannot be so efficient if, to prevent being struck, they be always kept moving about. If never hit, they will of course receive no damage; but if ships are to resort to such manœuvres to avoid the enemy's fire, they do not seem adapted to bring great actions to a speedy conclusion. And how are such manœuvres to be managed with damaged rudders and disabled screws? Naval engagements will, in my opinion, be settled hereafter, much as they have been heretofore—the victory will be with the heaviest metal and the greatest daring. And after the various discussions that have been raised on this point, fixed and floating batteries will be found each to have their uses; and it is, I think, a limited view of the question that leads to an undue exaltation of one over the other. If land-batteries are, as some have urged, so innocuous to ships, why was Cronstadt not taken?

A very important question, viz., the use of iron for ships and forts, and war purposes generally, is now undergoing the investigation of a committee specially appointed for the purpose, and it is to be hoped that their labours will lead to some important conclusions.

As it respects the question of armour plates, or of iron to be used for similar purposes, it would not seem that the hardest iron will prove the most suitable, unless it be combined with the greatest toughness. The force of impact is in a sense infinite. A ball cannot be arrested instanter in its flight. The thing struck, or the ball that strikes, must, one or both, possess some elasticity or ductility, or, if not, one or both must go to pieces. Of course the object to attain, as it regards both ships and forts, will be to devise a structure that will best arrest arrest the shot; but we have not yet arrived at the best mode of doing this.

The use of iron is extending on every side. Its manufacture is also, I am glad to say, improving. There was great room for its improvement. Several processes for converting it largely into steel, or into a metal approaching steel in character, are also now in use, and promise to afford an article at a moderate price double the strength of ordinary iron. These discoveries will tend still further to extend the use of iron.

Should it turn out that steel, or homogeneous iron as it is sometimes termed, uniform in quality, and of double the strength of ordinary iron, can be manufactured in large quantities at a moderate price, and can be easily manipulated; then, many things that are now with difficulty accomplished will be greatly facilitated, and some things which cannot be done at all, will be rendered practicable.

Bridges of greater span could be constructed. Screw shafts, crank-axles, and other parts of steam-engines, at present of unwieldly size, would by its use be reduced to more moderate dimensions. There seems to be no limit to the size of guns, except that of the strength of the material, and the power of welding, forging, and handling them. Cannon, as we know, have already been greatly increased in power by adopting a superior material in their construction. Could we hit upon an inexpensive mode of doubling the strength of iron, the advantages to all sorts of machinery might be equal to those that would flow from the discovery of a new metal, more valuable than iron has hitherto been.

We are, I believe, in the infancy only of discoveries in the improvement of the manufacture of steel and iron. Until lately the nature of the demand for iron rather retarded then encouraged improvements in its manufacture. Railways consumed iron in vast quantities, and railway companies cared nothing about quality. They were driven to seek a tolerably good material for engine and carriage tyres, but as it respected the vast consumption in the shape of rails, they were implicitly guided by the lowest prices. As long as this system continued it suited the ironmaster to manufacture a cheap article in large quantities, and they therefore gave themselves no concern to establish a better state of things. But heavy engines, high speeds, and an enlarged traffic are gradually working a change. We are beginning to find that iron of the very best quality has hardly endurance enough for rails or locomotive tyres; that there is no economy in putting down rails which require taking up again in a year or two: and in short, that the increased strains arising from the accelerated motion of railways, steamboats, and machinery generally, are necessitating a better material.

In marine steam-engines, which have received much attention, and where great attempts have been made at perfection, paddle-shafts, crank axles, screws and other portions have, as before intimated, already attained an unwieldly size, and the vis inertia and weight of such masses of metal are of themselves no slight impediment to the improvement of steam navigation, and would be greatly obviated by use of a stronger material.

Fortunately for this country, just at the time that the use of iron is extending, and improvements in its manufacture are developing, fresh discoveries are made of the raw material, and men seem to stumble, as it were by accident, on new fields of iron ore, in places where those mineral riches have laid dormant for centuries, to await a new era and another age, when ships, like knights of old, are to go forth to battle in complete armour, and when the civil engineer has assumed the duties which devolved on the smith and armourer of former times.

Having noticed some of the advantages that may flow from a greatly improved quality of iron or a cheap manufacture of steel, or of a metal approaching steel in character, I may call attention to the great facilities that have arisen from the use of iron cylinders in sinking and securing foundations.

Before this invention, masonry built under water had to be performed by divers with helmets, or by means of diving-bells. That mode of construction does not admit of the best work. The stones are laid without mortar, and depend for their security on their large size, and on a good arrangement of bond.

It is true that concrete work (which, however, is inferior to masonry) could be built under water without either divers or diving-bells; by passing the concrete through the water to its destination in boxes or by means of shoots, and giving it the requisite form by casings of timber or iron.

This mode of building has long been adopted on the shores of the Mediterranean, and the docks and quay-walls at Genoa have been built in this manner.

But the use of iron cylinders not only admits of masonry or brickwork being built in mortar under water in any form, and with any bond, but enables the engineer to excavate under water and to examine the ground before he begins to build, and to proceed with his work with as much deliberation, method, and security, almost with as little delay, when 70 or 80 feet below the water level, as he can do on dry land.

Hitherto this method has been mainly confined to the use of circular cylinders, sometimes used (as was done by Mr. Brunel in the case of the Saltash bridge) as a means of building the requisite pier of subaqueous masonry, the iron being afterwards taken away, and sometimes to enable the requisite piers of concrete, brickwork and masonry to be executed, and by allowing the iron cylinders to remain afterwards to protect the interior work.

In other cases, the cylinders themselves are used to support the incumbent weight, and they then act simply as piles.

But it appears to me that this method of building may be extended with advantage much farther than it has been. It is adapted to almost any form of pier, and might, in certain cases, be usefully applied in building continuous walls, and I know of no system that is likely to afford greater help to the engineer.

I have already said a few words on the progress of invention. This method of building is an illustration of the slow progress of really useful things.

In 1841 a patent was taken out for "improvements in the means of and in the apparatus for building and working under water:" and soon after the construction of the Rochester bridge, where cylinders were sunk under air-pressure, an action was brought against Messrs. Fox and Henderson, the contractors for the bridge, for an infringment of that patent. I happened to be engaged on that trial; and the fact was then brought to light that many years before, the late Earl Dundonald (then Lord Cochrane), had taken out a patent for a similar purpose very perfect in most of its details, for the drawings attached to Lord Cochrane's patent showed an air-lock almost identical with that now in use, and contained all the requisite arrangements for success. Lord Cochrane proposed to use it for overcoming difficulties similar to those encountered in the execution of such works as the Thames Tunnel; he proposed in fact to excavate such works under air-pressure.

This is another instance of the fertility of mind of that extraordinary man, who, great as he was as a sailor, would probably have been equally eminent as an engineer; and I here offer as a tribute to Lord Dundonald's memory this recognition of his early attempts to introduce the important system to which I have just been referring.

But we live in an age when men's minds turn to mechanical inquires, and when probably they were never more fruitful in mechanical resources.

It is almost needless to give examples of this fact. The locomotive engine is a familiar instance, and railway machinery generally affords many illustrations. The beautiful cotton-combing machine invented by Joshua Heilman, of Alsace, which was first used in the cotton manufactories to separate the fine from the coarse fibre, and has since been applied to wool, flax, and silk, and which acts almost with the delicacy of touch of the human fingers, is another illustration. Scheutz's calculating-machine is another remarkable instance, and many other cases might be named.

There is one subject, however, connected with mechanics which has hitherto been barren of result, about which men will occasionally occupy themselves, viz., the discovery of a new motive power.

The steam-engine, however, remains the only tame giant that is usefully subject to the will of man.

The little that has been done in the way of its improvement, since it left the hands of Watt, speaks volumes to the sagacity, industry, and untiring perseverance of that great man.

The late Mr. Kennedy, of Ardwick House, who was on intimate terms of personal friendship with Watt, on one of his last visits to Soho, asked him if he had discovered anything new in the steam-engine. "No," he replied, "I am devoting the remainder of my life to perfecting its details, and to ascertaining whether in any respect I am wrong." What the labours of that life produced we all know, and the patient concentration of will on his great object reminds one of Newton's similar labours in the perfection of his theory of gravitation, and evinces in the one case, as in the other, the truly great and philosophical mind, which is capable not only of discerning the dawnings of a great truth, and of appreciating its magnitude, but also of patiently pursuing its evidences until the whole is made clear as noon day.

At present it seems improbable, so long as motive power is to be obtained through the intervention of heat, and until a cheaper fuel than coal can be found that the steam-engine will be superseded by any other machine.

Electric magnetic machines are perhaps the least likely of all inventions to supersede the steam-engine. The consumption of a grain of zinc, as Mr. Joule has shown, though much more costly than a grain of coal does not produce more than about one-eighth of the same mechanical effect.

It would not, however, be at all safe to predict that considerable improvements may not yet be made in the steam-engine, or in engines to be worked by coal.

The consumption of fuel in the best steam-engines has been reduced to 2½ pounds of coals per horse-power per hour; but such an engine does not utilize one-fifth part of the absolute mechanical value of the coal consumed, and so long as this is the case, it would be unwise to assume that we have attained the utmost limits of improvement.

On another great branch of engineering, that of docks and harbours, I am not aware that much that is novel can be noticed.

The progress of such works is generally too slow to admit of much change in short periods of time.

An interesting discussion on the subject of harbours took place during a preceding session of this Institution. A considerable portion of that debate turned on the question of how far such works should be made permanent in the first instance, and how far they should be constructed so as to bring them into use with the greatest rapidity and at the smallest amount of cost, reckoning, of course, on rebuilding them at a future period.

This is one of those questions which it would be vain to discuss with any hope of coming to general conclusions.

In its naked form (apart from the question of harbours) it is one of the most simple and elementary questions. For it would not be difficult to show that if money alone be worthy of consideration, then, as it respects public buildings of all sorts, the cheapest system would be to discard solidity and ornament, and to adopt structures of a more temporary character, the plan in fact which is always adopted in new countries.

But wealthy nations, like rich individuals, will spend more on themselves and also more on their public works and buildings than the absolute wants of a nation demand, and the fact is that men are not governed by monetary considerations only, but also by a sense of what is or is not appropriate.

We have, however, some exceptions to this rule. There are, for instance, the the tattered and ragged margins of the Thames, where, in the greatest metropolis of the world, mud banks swelter and crazy buildings reel and totter against each other, but which it is proposed at a somewhat late hour to remedy.

Having thus touched upon the several points that occur to me as deserving of notice, I will conclude by remarking that no man can look back on the last twenty or thirty years without feeling that it has been the age of Engineers and Mechanicians. The profession to which we belong has in that period of time done much to change the aspect of human affairs; for what agency, during that period, single or combined, can be compared in its effects, or in its tendency towards the amelioration of the condition of mankind, with the establishment of railroads, of the electric telegraph, and to the improvement in steam navigation?

For in constructing railways, telegraphs, steamboats, and their adjuncts, docks and harbours, and moulding and fashioning the face of the material universe to the wants of man, in overcoming its barriers, overleaping its valleys, and spanning its seas, Engineers annihilate both space and time, bring into juxtaposition nations and people, and accelerate, beyond all human expectation, personal communication, and that interchange of ideas which is all important to the advancement of civilization and knowledge.

Distance and separation have led, and will always lead, to misapprehension and prejudice—to ignorance and mistrust—to rebellion and war; and engineers may feel, when labouring on the the great public works that facilitate the intercourse of nations, that they are not merely conquering physical difficulties, but that they are also aiding in a great moral and social work.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

October 29th, 1861, J. P. JOULE, LL.D., President, in the Chair.

Mr. Spence brought before the meeting part of a mass of iron and copper pyrites, containing an abundance of large and well defined crystals of pure arsenious acid.

Not only are these crystals a novelty as a natural product, but as an instance of rapid mineralisation they are interesting. The lump was found among a cargo of small disintegrated ore imported from Huelva, in Spain, and containing no solid masses of large size, and the lump was merely an aggregation of small pieces firmly agglutinated together and full of hollow cavities, studded over with the crystals of arsenious acid; and from the history of the cargo of ore it is not probable that more than twelve months has been required for their developement. Heat does not seem to have been the cause of the metamorphosis, as there is no evidence of heat at all approaching to ignition having occurred; discolouration of the ore would at once have been the result of this.

The ore is chiefly a sulphide of iron and copper; but as an arsenide of one or both of these metals exists in it, decomposition of this latter must have taken place; the arsenic has become oxidised, and crystals of arsenious acid are the result.

The piece of ore will be deposited in the Society's mineral collection.

The discovery of these crystals being pure arsenious acid was made by Mr. Bottomley, Mr. Spence's assistant in his laboratory.

An interesting conversation followed, in which the fact was stated that arsenic is a constituent of nearly all the artificial manures which have superphosphate of lime as their basis; and in connection with this a report was named of arsenic having been found in some of the crops grown with such manures.

Professor Roscoe exhibited the beautiful lithographic map representing the dark lines in a portion of the solar spectrum, lately published by Professor Kirchhoff. The lines are printed in ink of six different shades, and are of six different degrees of thickness, so that the leading features of the spectrum can be at once recognised. The position of the bright lines produced by the incandescent vapour of certain metals is also given on the map, and the coincidence of many of these with the dark Frauenhofer's lines rendered evident.

Professor Roscoe stated that the length of the drawings when complete would amount to some twenty feet, and that to give an idea of the scale on which the map was made, he might remark that the distance between the two double lines 'D" is upwards of four millimetres. These maps are as yet only printed, together with the memoir by Professor Kirchhoff, upon the Solar Spectrum and the Spectra of the Chemical Elements, in the Transactions of the Berlin Academy; an English edition will, however, shortly be published, giving a translation of the original memoir, and containing the same drawings of the spectrum as those exhibited, which accompany the German text.

Dr. R. Angus Smith read the first part of "An Examination into the Products of the Putrefaction of Blood." He found that 54° Fahr., or nearly so, was a marked temperature; that below it there was little putrefaction, but above it a large amount, which increased as the temperature increased as far as he tried, viz., to 72° F. The amount of gas given in twenty-four hours, from three quarts of diluted blood, was one hundred cubic centimetres, at 57° F. (16° Cels.), but on raising the temperature to 72° (22° Cels.) the amount of gas in the same period rose to 397 C.C., or four times the amount of putrefaction by fifteen degrees rise of temperature. When the temperature was below 54°, no gas could be collected for many days. A very short rise above 54° caused sufficient pressure to allow gas to be collected. These facts were used to illustrate climate and sudden spread of disease.

During the early period of putrefaction, the Author found sulphuretted hydrogen and organic matter to increase arpidly. One hundred cubic centimetres destroyed 29 of a solution of permanganate; the amount then rose rapidly to 36, 40·6, 41, 60·2.

Nearly ninety-eight per cent of the gas that escaped was found to be carbonic acid and gases with a similar action, *i.e.*, absorbed readily by caustic alkalies.

The gases were found to be—

Carbonic Acid.	Sulphuretted Hydrogen.	Residue.
82·68	—	17·32
85·78	—	14·22
89·72	—	10·28
95·40	—	4·60
96·20	—	3·80
96·07	1·58	2.35
96·43	2.78	0·79
97·62	0·06	2·31
97·09	1·93	1·98

The residual gas was found to consist of—

Carbonic Oxide	4·8	per cent.
Carburetted Hydrogen	2·5	„
Hydrogen	6·2	„
Nitrogen	86·5	„
	100·	

Where the sulphuretted hydrogen is 1·5, the sulphur is to the carbon as 1 to 24·8.

Both the oxygen and carbon of the carbonic acid are derived from the blood, which is therefore carried rapidly away.

The point of greatest importance was said, by the author, to be the separation of these substances, which do not seem to be pure gases, and which are entirely absorbed by alkalies, and partly by acids and metallic salts. The portion absorbed by acid salts was found to contain carbon and nitrogen, in the relation of 140 to 54, or as 100 to 38·5; but part of this was evidently as ammonia. In albumen it exists in the relation of 100 to 28·9. The whole of the putrefactive matters were not removed by acids or by acid salts. When the carbonic acid and sulphuretted hydrogen are removed, the putrefactive matters still remain. These gases, therefore, are not the only substances to be feared.

The condition in which these putrefactive bodies exist was then discussed. The Author believed that one of the conditions in which solid substances were taken into the air was in solution, the solution itself being taken up as a vesicle; and he instanced analogous cases, such as sulphuric acid and zinc when hydrogen is forming. The liquid evaporates and a concrete globule forms, leaving at last a portion of solid matter in various states. This condition can be supposed to occur readily in many cases, but it does not appear to be the probable result in all cases, as he cannot readily imagine vesicles coming through the close pores of bodies such as are penetrated by these vapours. Between the actually mechanical method of taking solid matter into the air, such as when waves are agitated by the wind, and the purely chemical method, such as when a liquid is transformed into a vapour by heat, there must be many intermediate stages. These stages are required, apparently, as we can scarcely imagine pure gases undergoing transformation similar to bodies in a putrefactive state, and we are not prepared with a theory by which diseases will be communicated without the agency of bodies in such a state of change—one of the oldest of theories and one promising to live long. Besides, the fact of a substance being found capable of being absorbed by metallic salts, and containing carbon with nitrogen in such a large amount, leads us to believe that bodies not very far removed from the substances decomposed are found in the vapours, and, if not far removed, capable of undergoing transformations so as to become farther removed, and by such transformations exercising their special influence.

MICROSCOPIC SECTION,

21st October, 1861, Professor WILLIAMSON in the Chair.

The Secretary presented sixty specimens of soundings received since the last Session, from the commanders of various steamers and sailing vessels, amongst which were a number from the South Coast of Ireland, Banks of Newfoundland, Coast of Nantucket, U.S., North Coast of Brazil, &c. The Secretary was requested to write a letter of thanks from the Section to each contributor.

The Chairman remarked that these specimens deserved the best attention of the Section, not only on account of their intrinsic interest, but to show the contributors that their kindness in preserving the soundings for the Section was fully appreciated.

Mr. Dale offered, with the assistance of the Secretary, to prepare the material, by separation from the tallow, &c., and Mr. Nevill. Mr. Heys, and several other gentlemen, offered their assistance in mounting, examination, and reporting to the Section.

The chairman observed that the method he employed in the preliminary examination of similar specimens, when freed from tallow and dried, was to stir the mass in a vessel of water, when most of the organic forms rose to the surface, in consequence of containing small quantities of air; the creamings off the top of the liquid would be found to contain sufficient indications whether the specimens deserved further attention.

REVIEWS AND NOTICES OF NEW BOOKS.

A Manual of Civil Engineering. By W. J. MACQUORN RANKINE, C.E., LL.D., F.R.SS., London and Edinburgh, &c. London: Griffin, Bohn, and Company, Stationers' Hall-court, 1862.

We hail with considerable satisfaction the appearance of another of Professor Rankine's admirable treatises. We have received it too late in the month to enable us to do full justice to it on the present occasion, and we therefore reserve, for our next number, a careful analysis of the contents of the book. For the present, however, we may state that a careful perusal of the contents, and a reference to the body of the work, enables us to express an opinion of the admirable manner in which Professor Rankine has treated the various subjects included in his "Manual of Civil Engineering."

We perceive that he has been enabled, by a reference to his "Applied Mechanics," and to "The Steam Engine and other Prime Movers," to materially abridge the extent of his present work, and thus, within the 776 pages to which the present manual extends,—to include a greater amount of useful information than has been collected in any other work within similar limits.

The Engineers', Architects', and Contractors' Pocket-book for 1862. London: Lockwood and Co., Stationer's Hall Court.

This annual publication, formerly known as *Weale's Engineers' Pocket-book*, has again made its appearance with several additions and improvements introduced therein. Amongst other recent additions is a map showing the metropolitan main sewage system, the works for which are now in course of execution. We notice, too, the additional notes on toughened cast-iron, on the various mixtures preferable for castings, and on the construction and comparative cost of wrought-iron beams, extracted from a recent work by Dr. Fairbairn. Altogether the pocket-book is improved.

Elementary Treatise on Physics, Experimental and Applied. By Professor A GANOT; Translated and Edited by E. ATKINSON, Ph.D., F.C.S. (Part 2) London, 1861: H. Ballière, 219, Regent-street.

We noticed in THE ARTIZAN of November last, Part I. of the above elementary treatise; since when Part 2 has been issued, and the division devoted to Hydrostatics is continued. The work is profusely illustrated with woodcuts, which are in themselves excellent specimens of that art. Altogether the work has been got up in a highly creditable manner.

NOTICES TO CORRESPONDENTS.

J. P. C. (Neath).—If you will send us your address we will endeavour to have a copy of the paper forwarded to you by the Secretary.

C. B.—The new paddle-wheel express steam ships for the South Eastern Railway Company, were tendered for upon a specification issued on the 21st November, 1860. The company's engineer adopted as a standard the *Lord Warden* and *Princess Eleanor* for the general dimensions and other elements requisite for enabling the selected firms to tender for the new boats and their machinery. We have for some months past been collecting the details of the specifications having reference to the tenders furnished by the various contractors, in answer to the invitation issued by the Company; as we are unable to find space in our present number for a form of "return" containing all the particulars which we have been able up to this time to obtain, we will give it in our next.

GAS ENGINEER (Paris), X. (Paris), and P. F. (Marseilles).—The best authority on the subject is Mr. S. Hughes, of Park-street, Westminster, to whom we advise you to apply.

L.—We think Parnell's patent locks will be found best suited for your purposes.

T. & G.—Send a sketch of the improvement referred to.

PH. D.—The term "fishing," as applied to railway construction, no doubt originated from the French *afficher*, and from the similarity of the operation to that of "fishing" a mast or spar. We do not know where and when the "fishing" of railway bars was *first* practised; but, in a patent granted to John Day, dated 22nd January, 1835 (the enrolled drawing and specification of which patent was stolen from the Patent Office or Petty Bag Office), the mode of "breaking joint" and "fishing," for the purpose of making continuous lines of rails, is described and illustrated. Early in 1846, during the construction of the Manningtree viaduct, on the Eastern Counties or Eastern Union Railway, the engineer first welded the short lengths of rails together, and finding that defective, resorted to the use of "fish plates" or "lapping plates," for the purpose of "fishing" or joining the lengths of rails together. Mr. Peter Brough was, we believe, the Company's engineer, and Mr. A. Ogilvie, the contractor for the works. In May, 1847, Messrs. Adams and Richardson patented a mode of "fishing" rails, and they formed what is described as a "suspended joint" between two chairs. In Wild's patent for improvements in "fishes" and fish-joints, for connecting the joints of rails on railways, dated March, 1853, he proposed to make the "fish plates" with a longitudinal groove in one or both sides of each "fish," so as to reduce the quantity of metal at that part, and to receive the square heads of the bolts, which are thus prevented from turning round when the nuts are being screwed on. It is not claimed by Wild that the groove serves any other purposes than those stated; as, for instance, it does not prevent the nut unscrewing, nor the joint and "fish plates" becoming loose. Several plans have been patented for effecting the latter object, which is by far the most important, whether for "fish plates" of one kind or another; amongst them, is a plan we have recently seen and think well of—it is patented by Messrs. Johnson (screw pile) and Hockin—it ought to answer in practice. We do not know whether it has been put into use. There has been considerable litigation about "fishing" rails, and we really do not know accurately what is the present state of the affair, or we would inform you with pleasure.

ALCHEMIST.—We are sadly puzzled to comply with your request, to be informed of what crucibles are best suited to melt *your* "hard brass." It is exceedingly difficult to say, judging from your letter, what kind of crucible is capable of performing that feat; but we know that those manufactured by the Patent Crucible Company at Battersea, are found, by those who have long used them, to give great satisfaction.

CANADIAN.—The area of your safety valve should have been equal to 12 square inches; the proportion of the surface condenser may be about 6 square feet to each horse power.

IRON WAR SHIPS AND IRON ARMOUR PLATING.—A correspondent writing upon the subject of a more thoroughly perfect and practical method of employing iron and fitting it together for naval purposes, contrasts in his letter the weight of the armour plating, teak backing and frame of the *Warrior's* sides, with a mode of construction proposed by him, in which bolts and screws or rivet holes through the plates, are dispensed with; and, the fitting in place of the armour plating and sides of such a vessel as the *Warrior*, is rendered so simple that one month would be amply sufficient to enable the whole of the frames and plating from stem to stern on each side to be erected and firmly secured. The writer proposes to dispense with the teak wood backing, and to employ plates of 7 inches thick, exclusive of the internal ribs and projections. By his calculations, he makes the weight per superficial foot of the armour plated sides of the *Warrior*, as 3cwt. 1qr. 2lbs., whilst the weight, according to his plan, if the plates are 7 inches thick (and with heavy ribs), instead of 4½ inch plain plates, would be 4cwt. 2qrs. 4lbs.; but his strength, it appears to us, are excessive. The following are his particulars of the dimensions and weights of the *Warrior's* top sides, or those parts which are armour plated:—

Armour plates 4½ thick, 180lbs. per superficial foot.
Teak backing, 18ins. 47lbs. per cubic foot = 71lbs. ditto.
Skin of ship, at ¾in. thick, 30lbs. including rivets, 33lbs., ditto.
The frames amidships are 22ins. centre to centre, and are at least equal to 3ft. depth of 1in. iron; therefore per foot run they weigh 120lbs.

	Lbs.
Taking a length of. 22ft there will be 11 frames, which at 120lbs. per foot, gives ...	1320
Armour plating, 22ft., at 180lbs. ...	3960
Teak backing, 22ft., at 71lbs....	1562
Skin of ship ¾in. thick, 22ft., at 33lbs....	726
Longitudinal angle iron 5 × 4 × ½; 7 double bars in 21ft. depth, at 33lbs. per foot = 726 ÷ 3 = ...	262
Inner skin at ½in. thick, supposing it to cover ⅓ of area, at 20lbs. per foot = 440lbs. ÷ 3 = ...	147
Inner teak lining, at 2ins. thick, covering ⅓ area at 9½lbs. per foot = 209 ÷ 3 = ...	69
Per foot in depth of *Warrior*, for a length of 22 feet ...	8046
	7
Weight of area, 22ft. × 7 = ... 154)	56,322
	362·72

Weight per superficial foot of *Warrior's* side, 3cwt. 1qr. 2lbs.

Screw.—The idea is not new; a similar plan was patented by Mr. Bodmer many years ago, and a model of his invention may be seen in the South Kensington Museum. The Grooved Friction Gearing, patented by Mr. Robertson, of Glasgow, and now extensively employed for transmitting motion, is what you should employ, and will save you the trouble of perfecting the arrangement proposed in your letter.

Marine Engineer (San Francisco).—The plan referred to for constructing boilers, has been tried unsuccessfully in some Mediterranean screw steamers; they, too, had surface condensers, and a constant supply of fresh water was relied upon. You are too late, the plan having been patented about three years ago. This is, perhaps, fortunate, or you would certainly have spent your money uselessly in patenting such a boiler. A square form of the vertical legs, and the flat sides of the "leaves" or divisions, render them unfit to withstand great internal pressure, without altering their shape and becoming thereby strained and weakened, as well as from the alternate effects of expansion and contraction; whilst the intense action of the fire upon the lower parts thereof, and the deposit of solid matter internally in inaccessible places, very soon causes a burning away and destruction. The spaces between the outside of the tubes, and the inside of the leg or "leaf," is too small in your sketch; however, the thing will not do, and it is needless to add more. Had you paid attention to what has appeared in The Artizan, relative to the different kinds of surface condensers in use, you would not have made the enquiry as to the Rotary Air Condenser. If the tubes are properly fitted in the tube plates in Spencer's Surface Condenser, they should not shift or slide through the tube plate in the direction of the flow of the current of water.

D.—It is difficult to determine which is the *best* gas regulator in use. We have used the Franklin Furnace Company's (Manchester) Regulator fitted close to the meter,—than which nothing can act better.

R. N.—Messrs. John Russell and Co., of Upper Thames-street, and Messrs. James Russell and Sons, of Upper Ground-street, Blackfriars, are makers of steam tubes.

ERRATA.

In the Report of the Committee on Steamship Performance, Table 5, in the particulars of the screw steamer *Lancefield*, the following errata occur:—

Column 3; *for* "lighthouse" *read* lighthouses; *for* "13·661 "miles" *read* "13·66 nautical miles."

Column 5; *for* "bows" *read* "bow."

Column 6; *for* "quite ebb" *read* "quarter ebb, favourable."

Column 12; *for* "about 64,700" *read* "84."

Column 14, as well as the note at the end, require the following explanation:—"Actual speed, 10·6 knots; deduction for tide, 0·6 knots; speed through the water under sail and steam, at 84 revolutions per minute, 10·0 knots; previously ascertained speed under steam alone, at 84 revolutions, 9·6 knots."

Column 38, *insert* "inverted cylinder."

Column 55; *for* "12·7in." *read* "12·7lbs."

Column 60; *for* "2" *read* "with."

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Rolt *v.* the Attorney General.—This was an action tried in the Rolls' Court, from which it appears that Mr. Rolt, the shipbuilder, sought to recover from the Lords of the Admiralty the difference between the amount actually expended by him in completing ten vessels for the navy, and the amount due in respect of them, under four contracts entered into between the Lords of the Admiralty and Mr. Meyer, previous to his bankruptcy. Mr. Meyer's interest in the ships had become vested in the plaintiff. The contracts were dated in 1855. Owing to the advance in the price of shipbuilding materials, occasioned by the Russian War, the plaintiff, in completing the vessels, was obliged to expend a much larger amount than the contract price, for which he claimed to be indemnified. His Honour said that, in consequence of no agreement having been signed or drawn up between the Admiralty and the plaintiff, the question raised by him was not easy of solution. There was no evidence to show that the Admiralty contracted to secure the plaintiff against any loss on the completion of the vessels. If Mr. Meyer himself had completed them, he would not have been entitled to any indemnity against loss, and as the plaintiff had undertaken the work of completion in the place of Mr. Meyer, neither was he entitled to indemnity, and, therefore, the bill must be dismissed.

Neville *v.* Wright.—This was an action tried on the 27th ult. in the Court of of Queen's Bench for the infringement of a patent for certain improvements in the mode of annealing glass. It was tried before Mr. Justice Hill at the Newcastle assizes, and resulted in a verdict for the plaintiff. Mr. Manisty, Q.C., on the part of the defendant, subsequently obtained a rule to enter a verdict for the defendant, or for a nonsuit, or a new trial on the ground of surprise, that the verdict was against the weight of evidence, and urged several other grounds. The Court said the discussion led them to believe that there had been an infringement of the plaintiff's patent, and made the rule absolute in the alternative.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

A Monument is to be erected to the memory of Sir Humphrey Davy, at Penzance, his native place. It will consist of a granite column and base, surmounted with a statue of the great chemist, holding a safety-lamp in his hand.

Improvements in Saw Frames.—An invention has been patented by Mr. Greenwood, of Leeds, to effect an economy in the construction and in the setting up of machinery for sawing wood. A steam cylinder is set up in an inverted position on the top of the framework, within which the saw frame is mounted; and the saw frame is connected directly with the pendent piston rod or rods of the inverted steam cylinder. The traverse, therefore, of the piston will impart the requisite reciprocating motion directly to the saw frame, and avoid the necessity for providing a more extended foundation than is required to carry the framework of the saw mill; while, at the same time, this arrangement will involve the simplifying of the construction of the mechanism. Another improvement is to draw back the sawblades, after the completion of each cut from contact with the wood under operation; so that the saw-teeth may be clear of the wood during the ascent of the frame.

British Ships and British Seamen.—The mercantile marine of the British empire consists of 35,501 vessels, measuring 5,710,968 tons, and navigated by 294,460 seamen. The various divisions of the United Kingdom, and the British Possessions abroad, furnish the annexed figures in connection with the preceding statement;—

	Vessels.		Tons.		Crews.
England	21,007	...	3,709,615	...	168,415
Scotland	3,486	...	623,791	...	31,682
Ireland	2,271	...	253,336	...	14,109
Guernsey, Jersey, and Isle of Man	899	...	71,945	...	5,591
British Possessions	10,338	...	1,052,281	...	74,663
Total	38,501		5,710,968		294,460

Of the above vessels, 2337, with 500,144 of tonnage, are propelled by steam. The totals of ships, tonnage, and crews belonging to the British Empire for each of the last five years, as recorded in the latest registered returns are supplied in the following table:—

Year.	Vessels.		Tons.		Crews.
1856	36,012	...	5,312,436	...	267,573
1857	37,088	...	5,531,887	...	287,353
1858	37,751	...	5,609,023	...	288,345
1859	38,200	...	5,660,402	...	291,431
1860	38,501	...	5,710,908	...	294,460
Showing an increase in 1860 over 1859 of	301		50,566		3,029

The number of vessels built and registered in the United Kingdom and the British Possessions abroad during the last-named year was 1722, with a tonnage of 318,828 tons, thus apportioned:—

	Vessels.		Tons.
England	802	...	161,190
Scotland	172	...	39,196
Ireland	42	...	11,582
Guernsey, Jersey, and Isle of Man	31	...	2,442
British Possessions	675	...	104,418
Total	1,722		318,828

Sheerness Dockyard.—A piece of negligence which, but for its timely discovery must have caused a serious loss of life, occurred in the above dockyard on the 8th ult. The boilers for driving the powerful machinery used in the engineers' factory are situated in a separate building at the north end of the shop, immediately over which are rooms appropriated as offices for the chief engineer and his staff. It appears that the principal foreman of the factory, going his rounds, made the alarming discovery that the water in one of the boilers was almost, if not entirely exhausted, the result of which was that the tubes had actually fallen in upon the furnace bars. The machinery was immediately stopped; and there is no doubt but that in a few seconds the boiler would have collapsed, and a fearful sacrifice of property and life been the result, as the factory and offices above were filled with workmen and officials.

Annual Returns of Fires for 1861.—The report on fires in London during the past year has been issued, and states, *inter alia*, that the total number of calls during 1861 had been 1400. Of these, 89 were false alarms, 137 proved to be only chimney alarms, 1183 were fires, of which 53 resulted in the total destruction of buildings, &c., 332 in considerable damage, and 798 in slight damage. The fires of 1861, compared with 1860, show an increase of 127, and compared with an average of the 28 years during which the establishment has been in existence, the increase is 397. This list does not include trifling damages by fires not sufficiently important to require the attendance of firemen. Of these no record is anywhere kept, but they may be estimated in round numbers at 4000; neither does it include the ordinary calls for chimneys, which may be estimated at 3000.

HYDRAULIC PRESS.—Messrs. Westwood, Baillie, and Co., of Mill-wall, have recived Admiralty instructions to manufacture for Woolwich Dockyard, an appropriate hydraulic press of 1,000 tons power, to work six ponderous hammer heads, to be used for the bending and preparation of the iron slabs for armour plating the 91 gunship *Caledonia*, under construction in that yard. A new shed is being built alongside the building slip of the *Caledonia*, in which the press will be fitted, together with steam furnaces, forges, and all the appliances necessary for the despatch of work.

THE WROXETER EXCAVATIONS.—The work of excavation on the site of the ancient city of Uriconinum is still progessing, and the men employed for this purpose are investigating the mounds and trenches said to indicate the boundaries of the ancient city. It has long been a question among Archæologists whether there ever was a storm defence as well as earthworks around the city, and hitherto attempts to discover the walls have been unavailing. Guided, however, by a large figured stone which has been from time immemorial in a rill of water which bounds the glebe land, the men cut a trench directly across the field, and here they found what is, no doubt, the real old wall of the town of Uriconium. They have found an actual stone wall exactly where the old Ordnance map places the walls. From about 8in. to 18in. below the turf they discovered a bed of rough, unhewn stone set in clay, and of no great thickness. It is exactly 6ft. wide, and has been uncovered for a distance of 34 yards, but it can be traced underground with a crowbar above 100 yards more in the adjoining fields. The stone wall is not on the top of the ridges, but on the outer slope of one ridge, giving a tract of high ground immediately within the walls. These interesting remains are believed to be only the foundations of the real wall, the superstructure having been carried away.

WOOD FOR SHIPBUILDING.—Professor Crace Calvert is now making an investigation for the Admiralty of different kinds of wood used in shipbuilding. It appears that the Professor is at no loss to explain why so many of the fleet of recently-built gunboats became rotten and others escaped untouched. He finds the goodness of teak to consist in the fact that it is highly charged with caoutchouc; and that, if the tannin be soaked out of a block of oak, it may then be interpenetrated by a solution of caoutchouc, and thereby rendered as lasting as teak. A few years ago an enterprising individual spent £30,000, in trying to introduce a new wood for shipbuilding purposes from South America, where it is known by the name of Santa Maria; but the dockyard authorities could not be persuaded to take it into use, and the imports were entirely neglected. This is one of the specimens investigated by the Manchester professor; and he finds it to be sound and resinous, and but little inferior to teak. Of the durability of teak there can be no question.

TOBACCO POISON.—It is considered by the most reliable authorities that the tobacco crop of the whole world amounts to 250,000,000 kilogrammes per annum. Schlosing has found that, taking one kind with another, there is an average of five per cent. of nicotine in the leaves of the plant; it is clear, therefore, that about twelve millions and a-half of kilogrammes of this poison are annually produced, As the specific gravity of nicotine very slightly exceeds that of water, this quantity would nearly fill 100,000 wine barrels, and would give twelve and a-half grammes (293 grains) to every man, woman, and child on the globe. As a few drops will produce death, it is probably much within the mark to say that the nicotine from one year's crop of tobacco would destroy every living creature on the face of the globe, if its proportion were administered in a single dose.

STEAM ON COMMON ROADS.—On the 21st ult., a heavy marine boiler was successfully removed from the works of Messrs. John Laird, Sons, and Co., Birkenhead, to the large crane situate on the margin of the Great Float, by means of Taylor's (Britannia Engine Works) "steam elephant," and a second boiler was removed on the 24th ult. This is the first instance in this neighbourhood in which steam on common roads has been employed for such a purpose. Judging from the easy manner this machine was guided over roads in a very indifferent state, and the distance it had to travel, it promises to become a most useful agent for transporting heavy loads, and it is equally applicable for discharging timber out of ships and afterwards drawing it upon the quay or from place to place, as required. One of these engines, manufactured by Messrs. J. Taylor and Co., of Birkenhead, has been at work for this purpose in her Majesty's Dockyard at Devonport, for upwards of two years, with great success.

OPENING OF THE EXHIBITION.—Her Majesty's commissioners have adopted the following regulations with respect to the admission of visitors to the Exhibition:—

1. The Exhibition will open, as previously announced, on Thursday the 1st of May and will be open daily (Sundays excepted) during such hours as the Commissioners shall, from time to time, appoint.

2. The Royal Horticultural Society having arranged a new entrance to their gardens from Kensingtion-road, the Commissioners have agreed with the Council of the Society to establish an entrance to the Exhibition from the gardens, and to issue a joint ticket giving the owner the privilege of admission both to the gardens and to the Exhibition on all occasions when they are open to visitors, including the flower shows and fêtes held in the gardens until the 18th of October, 1862.

3. There will, therefore, be four principal entrances for visitors:—1. From the Horticultural Gardens for the owners of the joint ticket, fellows of the Society, and other visitors to the gardens.—2. In Cromwell-road.—3. In Prince Albert's-road.—4. In Exhibition-road.

4. The regulations necessary for preventing obstructions and danger at the several entrances will be issued prior to the opening.

5. Admittance to the Exhibition will be given only to the owners of season tickets, and to visitors paying at the doors.

Season Tickets.

6. There will be two classes of season tickets. The first, £3 3s., will entitle the owner to admission to the opening and all other ceremonials, as well as at all times when the building is open to the public. The second price, £5 5s., will confer the same privileges of admission to the Exhibition, and will further entitle the owner to admission to the gardens of the Royal Horticultural Society at South Kensington and Chiswick (including the flower shows and fêtes at these gardens) during the continuance of the Exhibition.

Prices of Admission.

7. On the 1st of May, on the occasion of the opening ceremonial, the admissions will be restricted to the owners of season tickets.

8. On the second and 3rd of May the price of admission will be £1 for each person; and the commisioners reserve to themselves the power of appointing three other days, when the same charge will be made.

9. From the 5th to the 17th of May, 5s.

10. From the 19th to the 31st of May, 2s. 6d., except on one day in each week, when the charge will be 5s.

11. After the 31st of May the price of admission on four days in each week will be 1s.

Sale of Season Tickets.

12. Season tickets are now for sale between the hours of 10 and 5 daily, at the offices of her Majesty's Commissioners, 454, West Strand, London, W.C.

13. Applications through the post (stating Christian name and surname) must be addressed to the Secretary, and must be accompanied by post-office orders, payable at Mr. J. J. Mayo, at the post-office, Charing-cross.

14. No checks, or country notes, will be received.

15. Cases for preserving the season tickets may be obtained at the office for 1s. each.

By order, F. R. SANDFORD, Secretary.

NAVAL ENGINEERING.

THE BRITISH NAVY.—An official return, issued under the authority of the Lords of the Admiralty, embodying full details relative to the condition and stations of the vessels of the British Navy has just been published. "The number of vessels in commission on the 1st of January was 856, of all rates and classes. There were, besides, 150 line-of-battle and other sailing ships stationed at the various ports in England and the colonies, for harbour duty, thus swelling the total to upwards of 1000 vessels of all descriptions. Of the 856 vessels actually in commission, or building or repairing for service, only 154 are sailing ships, the whole of the remainder being propelled by steam power. The list of vessels is made up of 81 line-of-battle ships, each mounting from 74 to 131 guns; 22 vessels, each with an armament of from 60 to 70 guns; 44 51-gun frigates, the whole, with the exception of about ten of that number, being screw steamers; 57 ships, each mounting from 22 to 50 guns, and the majority of which have a tonnage as large as ships of the line; 29 screw corvettes, or frigates, each mounting 22 guns; 317 screw and paddle-wheel steamers, each carrying less than 22 guns; and 185 screw gunboats, each provided with two Armstrong guns. During the past year the following vessels were completed and launched from the various Royal and private dockyards:—The *Defiance*, 91, 3,475 tons, 800 horse-power; the *Perseus*, 17, 955 tons, 200-horse power; the *Shearwater*, 11, 669 tons, 150-horse power; the *Pandora*, 5, 426 tons, 80-horse power; and the *Aurora*, 51, 2,558 tons, 400-horse power, at Pembroke; the *Bristol*, 51, 3027 tons, 600-horse power, at Woolwich; the *Glasgow*, 51, 3038 tons, 600-horse power; and the *Chanticleer*, 17, 950 tons, 200-horse power, at Portsmouth; the *Rattlesnake*, 21, 1705 tons, 400-horse power, at Chatham; the *Speedwell*, 5, 428 tons, 80-horse power, at Deptford; the *Black Prince*, 36, 6039 tons, 1250-horse power, at Glasgow; the *Defence*, 18, 3668 tons, 600-horse power, at Newcastle; the *Resistance*, 18, 3668 tons, 600-horse power, at Poplar; the *Lily*, 4, 695 tons, 200-horse power, at Millwall; and the *Warrior*, 40 guns, at Millwall. The following is the list of the vessels of war now in course of construction, with the place at which they are building:—The *Achilles* (iron), 50 guns, 6079 tons, 1250-horse power, Chatham; the *Africa*, 4 guns, 669 tons, 150-horse power, Devonport; the *Agincourt* (iron), 50 guns, 6621 tons, 1250-horse power, Birkenhead; the *Alligator*, 22 guns, 1857 tons, 400-horse power, Woolwich; the *Belvidera*, 51 guns, 3027 tons, 600-horse power, Chatham; the *Bulwark*, 91 guns, 3716 tons, 800-horse power, Chatham; the *Caledonia* (iron-cased), 50 guns, 4045 tons, 800-horse power, Woolwich; the *Columbine*, 4 guns, 669 tons, 150-horse power, Deptford; the *Dartmouth*, 36 guns, 2478 tons, 500-horse power, Woolwich; the *Dromedary*, 4 guns, 500 tons, 100-horse power, Millwall; the *Dryad*, 51 guns, 3027 tons, 600-horse power, Portsmouth; the *Enchantress*, 4 guns, 835 tons, 250-horse power, Pembroke; the *Endymion*, 36 guns, 2478 tons, 500-horse power, Deptford; the *Enterprise*, 4 guns, 669 tons, 150-horse power, Deptford; the *Favorite*, 22 guns, 1623 tons, 400-horse power, Deptford; the *Guernsey*, 4 guns, 695 tons, 200-horse power, Pembroke; the *Harlequin*, 6 guns, 950 tons, 200-horse power, Portsmouth; the *Hector* (iron), 32 guns, 4063 tons, 800-horse power, Glasgow; the *Helicon*, 4 guns, 835 tons, 250-horse power, Portsmouth; the *Ister*, 36 guns, 3027 tons, 500-horse power, Devonport; the *Jaseur*, 5 guns, 425 tons, 80-horse power, Deptford; the *Menai*, 22 guns, 1857 tons, 400-horse power, Chatham; the *Minotaur* (iron), 50 guns, 6621 tons, 1250-horse power, Blackwall; the *Myrmidon*, 4 guns, 660 tons, 200-horse power, Chatham; the *Nassau*, 4 guns, 695 tons, 200-horse power, Pembroke; the *North Star*, 22 guns, 1623 tons, 400-horse power, Sheerness; the *Ocean* (iron-cased), 50 guns, 4045 tons, 1000-horse power, Devonport; the *Orontes* (iron), 3 guns, 2812 tons, 500-horse power, Blackwall; the *Psyche*, 4 guns, 835 tons, 250-horse power, Pembroke; the *Rattler*, 17 guns, 951 tons, 200-horse power, Deptford; the *Reindeer*, 17 guns, 951 tons, 200-horse power, Chatham; the *Repulse*, 89 guns, 3716 tons, 800-horse power, Woolwich; the *Robust*, 89 guns, 3716 tons, 800-horse power, Devonport; the *Royal Alfred* (iron-cased), 50 guns, 3716 tons, 800-horse power, Portsmouth; the *Royal Oak* (iron-cased), 50 guns, 3716 tons, 800-horse power, Chatham; the *Salamis*, 4 guns, 835 tons, 250-horse power, Chatham; the *Sappho*, 6 guns, 950 tons, 200-horse power, Deptford; the *Sylvia*, 4 guns, 695 tons, 200-horse power, Woolwich; the *Tamar* (iron), 3 guns, 2,812 tons, 500-horse power, Millwall; the *Tartarus*, 4 guns, 835 tons, 200-horse power; the *Trent*, 6 guns, 950 tons, 200-horse power; the *Triumph* (iron-cased), 50 guns, 3716 tons, 800-horse power; the *Tweed*, 51 guns, 3027 tons, 600-horse power, Pembroke; the *Salient* (iron), 32 guns, 4063 tons, 800-horse power, Millwall; the *Wolverine*, 21 guns, 1623 tons, 400-horse power, Woolwich; the *Zealous*, 89 guns, 3716 tons, 800-horse power, Pembroke.

THE "ROYAL ALFRED."—Four armour-plates for this iron-cased frigate have been received at Portsmouth Dockyard, from the workshop of Messrs. John Brown and Co, Sheffield. Each plate measures 15ft. in length, 3½ft. in width, 4½in. in thickness, and averages four tons in weight. The shipwrights are fixing the ship's outer planking of 8in. teak on her sides, which, when ready to receive the plates, will give 28 inches of solid timber in its weakest part, on which to hang her armour.

SHIPS' ARMOUR PLATES.—The *Times* states that one serious defect, of an almost irremediable character, exists in the construction of iron-cased ships as constructed at present, and is fully exemplified in both the *Warrior* and *Black Prince*. This evil is the penetration of water between the teak and armour-plates. The water naturally forces for its exit a passage between the joints of the armour plates, and the general opinion is that nothing can remedy this under the circumstances of tongued and grooved edged plates hung on a ship's side by through bolts. Caulking is stated to be useless on account of the slung weight to be dealt with, and the ship's motion at sea. But the effect of the action of the water in the groves of the plates and upon the iron belts can only be expected to be such that in four or five years from the time of commission each vessel will require replating.

THE "ARETHUSA," 51 guns, 3,141 tons, having been lengthened at Chatham Dockyard, converted from a sailing frigate to a screw steamer, and fitted with engines of 500-horse power by Messrs. J. Penn and Sons, got up steam at Sheerness on the 18th ult., for the purpose of testing her engines. The *Arethusa* is fitted with a pair of expansive trunk engines of 500 horse-power (nominal), diameter of cylinder, 7ft. 2in.; length of stroke, 3ft. 6in. The trial lasted five hours, the engines working very satisfactorily. The result was as follows:—Number of revolutions per minute, 61; steam pressure, 20lb.; temperature of superheated steam, 305 deg.; barometer, 26·5. On the 23rd ult. the new superheating and surface-condensing trunk engines of the *Arethusa* underwent a further trial. This trial was on the part of the contractors, Messrs. Penn and Sons. Mr. Spencer (the patentee of the surface condensers), and Mr. Appold (patentee of the centrifugal pump), were, together with Mr. J. Penn and many other gentlemen, present to watch the results. The trial was with four boilers, and superheated steam, when the pressure of steam was 20lb.; revolutions, 60; the temperature of steam being 300; and the vacuum, 26½. With half boiler power and two boilers, the pressure of steam was 19lb.; the revolutions, 42; and the vacuum, 25. Altogether the engines again worked in a very satisfactory manner.

THE "DEFENCE," 18, when under steam on the 15th ult., in a run from Chatham to Folly Point, attained an exceedingly satisfactory rate of steaming; a speed of 13 knots an hour being attained with only two boilers at work. From the trials already made to test her steaming capabilities, it is believed she will reach a speed of 18 to 20 knots an hour with her full boiler power.

THE "VIGILANT," 6, screw, made her official trial of speed at the measured mile in Stokes' Bay on the 2nd ult. Her draught of water was 12ft. aft, and 11ft. forward; pressure of steam, 15lbs.; vacuum, 21lb.; revolutions of engines, maximum, 84; mean, 80; mean speed of six runs, 9·833 knots. A complete circle was made under full steam in 5 min., 39 sec.

The "Royal Oak."—The moulds for the armour plates of this iron-clad frigate have been despatched to the Thames Iron Company, where the plates are to be manufactured. They are to be of rolled iron, and the edges are to be plain, without being grooved. Each plate will measure 15ft. by 3ft. 2in., and will weigh four tons. The machinery for bending the plates cold to the shape of the ship's side has also arrived from the factory of Messrs. Westwood, Baillie and Co. The bending process will be performed by hydraulic pressure.

The Ericsson Iron Battery.—This battery, in course of construction at Greenpoint under the direction of Captain Ericsson, is intended for the United States Government, subject to their approval. The hull of this battery is sharp at both ends, the bow projecting and coming to a point at an angle of 80 degrees, the sides inclining at an angle of 51 degrees to the vertical line; it is flat bottomed, 6½ft. in depth, 124ft. long, 34ft. wide at the top, and built of light ⅝-inch iron. Another, or upper hull, rests on this with perpendicular sides and sharp ends, 5ft. high, 40ft. wide, 174ft. long, extending over the sides of the lower hull 3ft. 7in., and over each end 25ft., thus serving as a protection to the propeller, rudder, and anchor. The sides of the upper hull are composed of an inner guard of iron, a wall of white oak 30in. thick, covered with iron armour 6in. thick. When in readiness for action, the lower hull is totally immersed, and the upper one is sunk 3ft. 6in., leaving only 18in. above the water. The interior is open to the bottom like a sloop. the deck, which is bomb proof, coming flush with the top of the upper hull. No bulwark of any kind appears above the deck, and the only things exposed are the turrets or citadel, the wheelhouse, and the box crowning the smoke stack. The inclination of the lower hull is such that a ball to strike it in any part must pass through at least 25ft. of water, and then strike an inclined iron surface at an angle of about 10 degrees. The battery draws but 10ft. of water.

Naval Appointments.—The following naval appointments have taken place since our last:—J. Snell, Engineer, and C. F. Gregory, Second-class Assist. Engineer, to the *Indus;* W. Farquharson, Engineer, to the *Revenge;* J. C. Weeks, and H. Benbow, First-class Assist. Engineers, to the *Cornwallis*, the latter for the *Fly;* A. Borthwick, First-class Assist. Engineer, confirmed, in the *Asia*, for the *Highlander;* H. Vatcher, Second-class Assist. Engineer, confirmed, in the *Surprise;* G. F. Gossage and T. Stewart, confirmed in the *Miranda* and *Defence*, respectively; W. Hardie, Engineer, to the *Cumberland*, for the *Racehorse;* H. Gair, Engineer, to the *Cumberland*, for the *Cormorant;* J. Hopkins, in the *Forester*, promoted to Engineer; H. Onions, Second-class Assist. Engineer, confirmed, in the *Impérieuse;* W. R. Abbott, A. Stewart, G. Francian, G. Nicholls, J. W. Compton, and E. Irish, Acting Second-class Assist. Engineers, to the *Impérieuse*, additional, for disposal; W. H. Sedgwick, promoted to First-class Assist. Engineers in the *Ajax;* R. Hodge, E. T. Read, W. Ash, H. G. Pilcher, J. Matthews, and J. E. Derrick, promoted to Engineers; J. Weir, W. Castle, and F. H. Morgan, promoted to Acting Engineers; H. Hammond, promoted to First-class Assist. Engineer; D. B. Keiller and R. Sutherland, Acting Second-class Assist. Engineers, to the *Asia*. as supernumeraries; J. T. Rose, Acting Second-class Assist. Engineer, to the *Cumberland*, and lent to the *Formidable;* H. Thomson and F. Smiley, Acting Second-class Assist. Engineers, to the *Asia;* J. H. Marshall, Chief Engineer, to the *Asia*, for the *Cæsar;* J. Sangster, Chief Engineer; G. W. Sivewright, Acting Engineer; R. Bacon, First-class Assist. Engineer; W. W. Webber, Acting First-class Assist. Engineer; C. C. Hyde, Second-class Assist. Engineer; J. West and J. Manley, Acting Second-class Assist. Engineers, to the *Shannon;* W. Hollowell and W. Crichton, to the *Indus*, as supernumeraries; G. Fordham and R. M. Rodger, Acting Second-class Assist. Engineers, to the *Cumberland*, as supernumeraries; A. Daver and W. Hankinson, Acting Second-class Assist. Engineers, to the *Asia*, as supernumeraries; J. Smith, Acting Second-class Assist. Engineer, to the *Asia*, for the *Tribune;* W. Birks and G. F. Williams, First-class Assist. Engineers, to the *Asia*, for the *Earnest* and the *Cracker* respectively; H. W. Hart, Acting Second-class Assist. Engineer, to the *Impérieuse;* G. Metcalfe, L. I. Croome, W. H. Wivil, G. T. Allison, J. Clift, A. Stewart, C. Lund, J. S. Smith, and J. Hopwood, promoted to the rank of First-class Assist. Engineers in the *Jackal, Cygnet, Indus, Revenge, Asia, Algiers, Mutine, Forward*, and *Odin* respectively; J. Francis, Second-class Assist. Engineer, to the *Shannon*, vice *Hyde;* G. Treves, Chief Engineer; G. M. Doyley, Engineer; W. H. Wivil, First-class Assist. Engineer; R. W. Meiklejohn, Acting First-class Assist. Engineer; and J. Bamford, Acting Second-class Assist. Engineer, to the *Euryalus*.

STEAM SHIPPING.

New Steam Shipping Company.—It is in contemplation to form a new Steam Shipping Company from Southampton to India, by the overland route. It is proposed that the service shall be continued fortnightly, the vessels of the proposed company running alternately with those of the Peninsular and Oriental Company. The capital is one million, and it is not contemplated to have any subsidy, as the promoters believe they can do better without it, as it leaves them free from any Government control. The directors, however, are seeking, and expect to obtain, the approval of Sir C. Wood, the Secretary of State for India.

The "Bahama."—On the 18th ult. there was launched from the building yard of Messrs. Pearse and Co., Stockton, a fine screw steamer, barque rigged, called the *Bahama*. The dimensions of this vessel are as follows:—Length between perpendiculars, 215ft.; breadth, 29ft. 3in.; depth of hold, 20ft. 9in.; tonnage (O.M.), 898. Engines, direct-acting, by Messrs. Fossick and Hackworth, 140 horse-power.

The Messageries Imperiales Company have, it is understood, concluded a contract with an English firm for the construction, for £1,000,000, sterling, of eight first class iron steam vessels for packet service, three to be built on the Clyde, and five in ports of France, under the superintendence of the firm. The first English built one is to be completed within 19 months, and the others at successive intervals of two months from the expiration of that term.

Paddle-wheels for the "Great Eastern."—Messrs. Brotherhood, of Chippenham, are entrusted with the construction of the new paddle-wheels for the above-mentioned leviathan steamship. The diameter of the wheels over all will be 52ft., their width 13ft., and the depth of the floats, which will be formed of stout beech, will be 2ft. 9in. The new paddle wheels will be in every way materially stronger than those with which this vessel was originally furnished.

The "Great Eastern" Disaster.—The fellow-passengers of Mr. H. E. Towle C.E., of Boston, U.S., in the recent unfortunate trip of the *Great Eastern*, have presented him with a handsome and valuable gold watch, in token of their gratitude to him for his timely and valuable services in adjusting a plan for steering the ship into port when all other means had failed, and to which they attribute the rescue of themselves and ship from impending destruction.

RAILWAYS.

The Somerset and Dorset Central Railway was opened on the 18th ult. from Glastonbury to Temple Coombe, a distance of 21½ miles.

Great Northern Railway.—The plans deposited by this Company contemplate an improvement in what is known as their loop line, which commences by a junction with their main line near Peterborough, passing through Spalding, Boston, and Lincoln, and terminating at Gainsborough, and where it is not directly connected with the main line; and with this view the company propose that the loop line shall be extended to Rossington, and in the neighbourhood of Doncaster, and there join the main line. The levels of the loop line between Gainsborough and Saxilby are to be altered and improved, and the estimated cost of the proposed works is £330,000. The Company also propose to acquire additional lands at Doncaster.

British Railways.—From returns recently made, it appears that the amount of capital expended on railways in the United Kingdom, together with the cost per mile, the traffic receipts, and the number of miles open at the close of each of the two last years, have been as follows, viz.:

Year.	Capital expended.	Cost per mile.	Traffic receipts.	Miles open.
1861	£342,086,100 ...	£31,633 ...	£28,263,374 ...	10,811
1860	329,827,200 ...	32,106 ...	27,576,783 ...	10,273
Increase ...	£12,258,900 ...	...	£686,591 ...	538
Decrease ...	...	£473		

It thus appears that the receipt per mile during the last year was only £2615, while during 1860 it was £2685; so that it is evident that no benefit has been derived from the system of extension which has of late so generally prevailed, and in compliance with which an expenditure has been incurred during the year of more than 12¼ millions sterling, for which the returns made will be found to be very inadequate. The following are the returns of traffic receipts per mile:—1846, £3305; 1847, £2870; 1848, £2556; 1849, £2302; 1850, £2227; 1851, £2283; 1852, £2238; 1853, 2476; 1854, £2604; 1855, £2668; 1856, £2759; 1857, £2635; 1858, £2485; 1859, £2588; 1860, £2685; 1861, £2615. In the first of these years branches and extensions were still in their infancy, and the receipts per mile were higher than they have ever again been. After that period they gradually decreased, until the year of the Exhibition, 1851, when the downward tendency was arrested.

From Newport to Reading, Isle of Wight, a railway is proposed at a cost of £75,000.

Railway Pointsmen.—The directors of the Eastern Counties Railway have determined on a reduction of the daily duty of the men who have charge of the points, and a notice with that object in view has been issued. The important service entrusted to these men will undoubtedly be more efficiently performed under these regulations.

The East Indian Railway is now open for 320½ miles, in Bengal, and for 209¼ miles in the north-west provinces, or 529¾ miles in all.

Great Southern of India.—It appear that the line of this company to Tanjore, was opened for traffic on the 2nd of December last, making the length of line now in operation from Negahatam to Tanjore 48 miles, and it is expected that the remaining section to Trinchinopoly, 30 miles in length, will be opened in the present month.

The Eastern Counties Railway directors have determined on adopting a system of warming carriages with the waste steam from the engines. The plan has been for some time adopted on the French lines, and has recently been tried on the London and North Western.

French Railways.—The amount of capital required by the French Railway Companies for new works for the year 1862 is from £14,000,000 to £16,000,000, being rather less than the sum raised last year. The total required to finish all the lines conceded up to the present time, amounts to about three milliards of francs. Foreign railways conceded to French companies will require this year at least £10,000,000.

Traffic on French Lines.—The following is a statement of the traffic on the principal railways of the French empire, for each of the last three years, from January 1 to December 31:—

	1861. Francs.	1860. Francs.	1859. Francs.
Paris, Lyons, and Mediterranean......	121,672,710	101,931,597	101,977,747
Ditto new lines..............................	22,800,822	18,644,915	——
Eastern of France	69,632,617	63,408,308	59,354,920
Paris and Orleans	69,498,797	66,055,680	64,814,043
Northern of France.........................	64,199,775	60,759,398	57,845,901
Western ditto	55,213,555	50,940,267	49,304,383
Southern ditto	31,607,421	25,765,454	22,721,746
Lyons and Geneva	7,226,237	6,764,852	6,359,877
Ardennes	4,115,521	3,641,783	3,287,711
Francs..............................	445,967,455	397,912,254	365,666,328
Pounds sterling	£17,838,698	£15,916,490	£14,626,653
Miles open..........................	5,797	5,542	5,490
Traffic per mile..............	£3,077	£2,872	£2,664

There is thus shown to have been a steadily progressive increase in the traffic on these railways, which speaks well for the system of management which has been adopted in that country, and which also proves that, though the French were long in making any decided movement in their works for this mode of communication, they have not failed to make good use of this delay, for they have thus been enabled to avoid many of the mistakes which had at the outset been committed in this country, and to turn to account most of the improvements which our experience had placed at their disposal. The following is a comparison between English and French railway traffic for the last two years, done in a tabular form:—

	English.		French.	
	1861.	1860.	1861.	1860.
Traffic receipts	£28,263,374	£27,576,783	£17,838,698	£15,916,490
Miles open...................	10,811	10,273	5,797	5,542
Traffic per mile............	£2,615	£2,685	£3,077	£2,872

As it is thus seen that, with little more than half of the English mileage, the French receipts do not fall much short of two-thirds of the English traffic.

Southern Italian Railway.—A train recently opened the line of railway from Rome to Ciprin, on the Neapolitan frontier, and there is now little doubt that the whole line between Rome and Naples will be immediately completed. It was feared that some delay might have been caused by the non-completion of the viaduct over a large valley at Velletri; but, although on the 1st of December this bridge, which is almost a reproduction of the Crumlin Viaduct, South Wales, of nearly 500ft. in length, and 170ft. in height, was scarcely commenced; by the exertion of the contractors, Messrs. Kennard, Bros., of London, a train passed over it on the 30th.

MILITARY ENGINEERING.

Thames Defence.—In addition to the powerful forts and batteries which are now under construction at the entrance to the Medway, two exceedingly strong batteries are being erected a few miles up the Thames, on the Essex and Kent sides of the river, about mid-distance between Gravesend and the Nore, in order still further to protect the river, should any hostile vessel succeed in accomplishing the almost impossible feat of passing the guns of the fortifications on the Isle of Grain and the batteries at Sheerness. Notwithstanding the numerous and almost insurmountable natural difficulties which have been experienced during the progress of the undertaking ever since its commencement, especially in driving the piles on which the structure will be reared, the works are being pushed forward as rapidly as circumstances will permit. The battery at Coalhouse Point, on the Essex side of the river, will probably be completed some time before that at Shornmeade, on the opposite shore, it being considered desirable to finish it as early as possible, in order that the armament may be placed in position. The Coalhouse Point battery is being erected on the site of the small line of fortifications which were built a few years since, at considerable expense, the whole of which are now levelled. This will be the larger and more important of the two batteries. The utmost care and skill are being used in preparing the foundation. In consequence of the soft, spongy nature of the soil, nearly every inch of the ground has been piled to a depth of some 30 or 40ft., 12 steam pile-driving machines being used in this portion of the undertaking. The beds of concrete on which the superstructure will be raised are of enormous strength, and apparently capable of supporting any weight. The battery will be bomb-proof, with two tiers of guns, the tier above being placed *en barbette*. The walls will be no less than 12ft. in thickness of solid masonry, over which again will be placed layers of concrete and asphalte. Each battery will also be furnished with furnaces and cupolas for preparing red-hot shot and filling the shells with molten iron. The two forts, which stand at the important junction of Lower Hope and Gravesend Reaches, will thus cross their fire either against any force ascending the Lower Hope or in rear of a hostile fleet should it have succeeded in forcing this difficult bend of the stream, which would again be met by the sweeping fire of the heavy armament mounted at New Tavern Fort, on the Kent shore, and that of Tilbury Fort, on the Essex side, the latter having a direct bearing down Gravesend Reach. The armament intended to be mounted on the new fortifications will be fitted with flanged trucks and raised racers, the invention of Col. Colquhoun, Royal Artillery, which, after repeated and severe tests, has been found to be far superior, in point of durability and strength, to the old pattern principle of flat racers and front pivots.

TELEGRAPHIC ENGINEERING.

ADEN AND KURRACHEE.—The steamer with the new cable for the repair and restoration of the eastern division of the India telegraph, between Aden and Kurrachee, left London on the 1st January. Attention will be first directed to the land line belonging to the company between Alexandria, Cairo, and Suez, which will be at once made available, so that a temporary station may be established during the course of next month at the entrance of the Gulf of Suez, upon one of the islands of Shadwan or Jubal, at which telegraphic messages to and from India, China, and Australia will be received and despatched. This line, extending a distance of 360 miles from Alexandria, will shorten the time by about 36 to 40 hours.

TELEGRAPHIC COMMUNICATION BETWEEN ENGLAND AND IRELAND.—In order to receive news brought by the American packets as they touch at Queenstown, it is necessary that the despatches should be forwarded by telegraph a distance of nearly eight hundred miles. When the steamer calls at Queenstown, its news has to be transmitted from Cork to Dublin, thence to Belfast, thence to Donaghadee, across the Channel to Portpatrick; from thence to Dumfries, then to Carlisle and Liverpool, and finally to London. This involves great delay, and numerous breaks in the communication. The steamers call off Roche's Point, and a steamer is now required to convey the despatches up the harbour to Queenstown, the time occupied being an hour and a half. Important as news may be, there is no telegraph from Roche's Point to Queenstown. It is now proposed to establish a new telegraphic line, which will place Queenstown not only in direct communication with the telegraph station at the entrance to the harbour, but also with the Old Head of Kinsale, from whence the Atlantic steamer may be sighted several hours earlier than is at present the case. Permission has been given to lay a telegraphic wire from Roche's Point, which will be carried on to Queenstown and join a main line which will connect Cork and Queenstown with Waterford and Wexford, and thence run to Carnsore Point, projecting a considerable distance into St. George's Channel. At this point the line will be submerged to St. David's Head, on the Welsh coast, and be continued through Milford, Gloucester, and Bristol, direct to London, the whole line being about half the length of that at present required to connect Queenstown and London. The Electric and International Telegraph Company are to construct at their expense all the necessary land lines, and Messrs. Glass, Elliot, and Co. have entered into a contract with the new company to lay the submarine portion, and have undertaken to guarantee its efficiency for eleven years; the whole to be completed in two months.

TELEGRAPHS IN AUSTRIA.—From returns which have recently been published by the Austrian Government, it appears that there are now in that country 1741 German, or about 8200 English miles of telegraph, with 214 stations and 3267 German, or about 16,000 English, miles of wire. The average cost of the wire has been about 1000fl. per mile, and of the posts and other materials between 600fl. and 800fl. per mile. New lines of internal communication are proposed to be added during the present year, and for these it is calculated that an outlay of 494,800fl. will be required, which is a considerable increase on last year, when 308,900fl. only were expended on them. All the lines now in operation and projected will afford a regular telegraphic communication between Vienna and Prague, Prague and Pilsen, Bodenbach and Aachenberg, Freiwaldau and Troppau, Cracow and Tarnow, Przemysl and Lenberg, Trieste and Agram, Steinbruck and Sissel; Sissel, Bukovar, and Semlin; Vienna and Temesvar, Szegedin and Bezdan, Ragusa and Spalato, Cittadella and Castelfranco, and finally between Vicenza and Ricoaro. The net revenue for the year is estimated to amount to 402,000fl., which is an increase on the previous year by 83,000fl.; but this has been chiefly derived from the lines in the interior, in addition to which, and in connection with them, there has been laid a submarine cable between Austria and the Ionian Isles and Greece, which is intended eventually to form a portion of the Indian and European line of telegraph. In connection with this there is also an English submarine line between Corfu and Malta; and, when the proposed communications between Malta and Tripoli and between Tripoli and Alexandria are carried out, Austria will have the benefit of a continuous line to Egypt. In addition to these, a telegraphic communication is projected from Ragusa through Greece, by which a new and most desirable route of telegraph will be opened to Constantinople, and, as a line is laid from Corfu to Otranto, the means of rapid intercourse between the Levant and Northern and Southern Italy will thus likewise be attained. The estimated expenditure for all these new lines will this year amount to 1,479,800fl.; but, as it is reckoned that there will be a surplus revenue from the old lines of 432,000fl., the sum that will be required will not exceed 1,047,800fl.; and, even in the present unsatisfactory state of Austrian finance, it is not doubted that this will without difficulty be made forthcoming when all the benefits that are to be derived from its expenditure are duly considered.

THE CAPE OF GOOD HOPE government have subsidised a line of telegraph between Cape Town and Graham's Town, and a line is also about to be undertaken in Natal between the seaport and the capital.

RAILWAY ACCIDENTS.

LONDON CHATHAM AND DOVER.—An accident occurred on the 25th ult. to the express down train of the London, Chatham, and Dover Railway, which leaves the Victoria Station for Dover at 6·40 A.M. The train arrived at Chatham at 35 minutes past seven, and after delivering the morning papers, proceeded on its journey. After passing the railway station at Rainham, a distance of nearly five miles from Chatham (the line being on an incline), one of the metals, after the engine and tender had passed over, flew up, causing the carriages, consisting of two of the first and second class, with the break, to run off the line. The carriages were dragged a distance of about a quarter of a mile without one of them being turned over, although they are much strained and injured by going over the ballast between the line of rails. There were only a few passengers in the carriages, none of whom received any injury.

ACCIDENTS ON FRENCH RAILWAYS.—The following official statement has been published: 2150 trains run daily on the lines of the Northern, Eastern, Western, Orleans, and Paris, to the Mediterranean Railway Companies, extending over a distance of 192,000 kilos., which makes 777,450 trains yearly, passing over a distance of more than 70,000,000 kilos. During this period the number of travellers who have lost their lives by railway accidents was forty-four, which is equal to one in 7,000,000 travellers.

ACCIDENT ON THE GREAT NORTHERN RAILWAY.—An accident involving the destruction of a considerable amount of property, happened at the Sandy Station of the Great Northern Railway on the morning of the 18th ult. About six o'clock an up luggage train was propelling some detached waggons up a siding at the station mentioned, when, from some unexplained cause, instead of continuing on the siding, the trucks took a line diverging to the left hand, and leading to the main rails. They therefore came on to the down main line. Simultaneously, there arrived a long down train of luggage waggons, and, before any steps could be taken either to caution the driver or to remove the obstruction, came in violent collision with the runaway trucks. The latter were scattered in all directions, the engine of the goods train—which at the time was nearly at full speed—being also much injured, and thrown on its broadside. The fireman escaped, but the driver was seriously injured. It is supposed that the severe frost which prevailed caused a pair of switches to stick instead of springing back, and so to open with the main line the communication which has led to the accident.

BOILER EXPLOSIONS.

ANNUAL MEETING OF THE MANCHESTER STEAM BOILER ASSOCIATION.—The seventh annual meeting of this Association was held in the Town Hall on the 21st ult., Mr. W. Fairbairn, LL.D., F.R.S., the President, in the chair. The following is an abstract of the report as read:—The number of members, as well as the number of boilers under inspection, have increased during the past year; and at the close of 1861 the Association numbered 430 members, and had under inspection, at 535 factories and other works, 1454 boilers and 1030 engines, representing approximately a total of 127,065 indicated horse power. The ordinary subscriptions, with the special service fees, amounted in the gross to £1266 6s. No explosion had occurred to any boiler under the inspection of this Association during the past year, while no less than 20 explosions were known to have happened in various parts of the kingdom, from which 27 persons had been killed, 47 wounded, and considerable damage done to property. 5612 boiler inspections had been made, 52 boilers being found in a dangerous state; while, with regard to 226 others, it was necessary in 145 that the furnaces should be strengthened by hooping; in 52 that the shells should be strengthened by additional stays; and in 29 that the load on the safety valves should be reduced. The Association have been in the habit, on the occurrence of any explosion within a reasonable distance of Manchester, of having a special examination and report made upon the boiler in question, so that the members should have the advantage of the information; and after alluding to the whole of the cases which have been examined in the course of the year, it was stated that it had been found that due care and periodical inspection, with the application, where necessary, of the hydraulic test, would have prevented every one of these explosions, and thus the word accident could not correctly be applied to any one of them. The report then went on to the consideration of engines and "Economy in the raising and use of steam," and pointed out the desirability of adopting a more satisfactory system than that now in use, which it is hoped the association will be the means of introducing ere long, stating that it would be extremely valuable if a complete table could be obtained of the actual net amount of fuel consumed, per indicated horse power, by each engine under the inspection of this Association. Such a table would form a true record of comparative economy, which would not only be useful to steam users, but also to manufacturing engineers, while it would establish a wholesome competition between all parties for the attainment of the highest degree of economic efficiency. The report recommended the application of steam casings or jackets to cylinders, and the adoption of superheated steam, stating the commercial advantages derived from these arrangements in other parts of the country, and concluded by stating that it was the desire of the Association constantly to diffuse among the entire body of members reliable information on all points relating either to the safety of boilers or the economic use of steam; carefully avoiding the recommendation of anything untried or experimental. In this way it was thought that the association would continue to be a source of wealth to its members, as well as to the surrounding district, and the earnest desire was expressed that no year should pass without a decided mark of engineering progress being clearly stamped upon it by the Association. After the adoption of the report, Mr. Bazley, M.P., moved the following resolution:—"That the meeting considers the system of voluntary periodical inspection to be worthy of the confidence of all steam users, and that this view is borne out by the fact that no explosion has occurred to any boiler under the inspection of this Association during the past year, while no less than twenty explosions are known to have happened in various parts of the kingdom. Also this meeting wishes prominently to call attention to the fact that in every case where exploded boilers have been examined and reported on directly to this Association, it has been found that the explosion resulted from the simplest causes, and might have been prevented by the exercise of due care. This meeting therefore considers that the labours of this Association have established the following principle, namely, that the causes of explosion have been shrouded in unneceseary uncertainty and mystery, and takes this opportunity of expressing its conviction that explosions are considered far too frequently to be accidental, and that by due attention to correct principles in the construction of boilers in the first place, added to care in their working in the second, the recurrence of explosions would be prevented." This resolution was seconded and passed, as also was the following, proposed by Mr. Harman:—"That this meeting calls attention to the safety of boilers, but includes all questions relative both to their efficient working and to the economic use of steam generally, and this meeting considers that the Association, by the assistance it renders to engineering progress, is commercially valuable, not only to its own body of members, but also to the district at large."

THE ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.—At the last ordinary monthly meeting of the Executive Committee of this Association, held at Manchester, on December 31st, 1861, Hugh Mason, Esq., Vice-President, in the chair; Mr. L. E. Fletcher, chief engineer, presented his monthly report, from which we take the following very brief extracts:—"During the past month 256 engines have been examined, and 364 boilers, 10 of the latter having been examined specially, 4 internally, 38 thoroughly, and 312 externally, in which the following defects have been found:—Fracture, 5 (1 dangerous); corrosion, 22 (3 dangerous); safety valves out of order, 9; water gauges, 4; pressure gauges, 2; blow-off taps, 13 (1 dangerous); fusible plugs, 5; furnaces out of shape, 6; total, 73 (5 dangerous). Boilers without glass water gauges, 22; pressure gauges, 4; blow-off taps, 18; feed back-pressure valves, 38. No explosion has happened to any boiler under the inspection of this Association during the past month, nor in fact throughout the whole year. A few cases of injury to furnaces have occurred, arising from deficiency of water consequent on the derangement of the glass water gauges, which would have been prevented had there been two gauges to each boiler, so frequently recommended. In another case, injury arose from the attendant lighting a fire in his boiler when empty, while, in another, from a defective blow-out tap. There has however come to my knowledge, in a casual way, the occurrence in various parts of the kingdom during the past year of no less than twenty explosions, from which twenty-seven persons have been killed and forty-seven wounded, the boilers in question being of every variety, —factory, colliery, marine, locomotive, agricultural, &c. Relative to 'economy in the raising and use of steam,' I have brought before the attention of the members during the past year the importance of surface blowing out, and the advantage to be derived from the use of steam jackets, as well as from superheating. Surface blowing out is in very general use elsewhere, and found successful; it is not monopolised by patents, but is free to all. The use of steam jackets and superheated steam, aided by surface condensation (a subject on which I shall take an early opportunity of communicating with the members), are now working a perfect revolution in marine engine economy, and are extensively adopted by various large steam navigation companies. In the report of the last annual meeting of the Peninsular and Oriental Steam Navigation Company, the chairman stated that a new vessel called the *Mooltan*, of 2,600 tons burthen, having engines of 400 nominal horse-power, in which the above principles had been adopted, the consumption of fuel had been reduced to rather less than one-half the usual amount; and the chairman added that the shareholders would readily perceive the importance of such a reduction in the consumption of fuel, when he reminded them that they had paid as much as £800,000 for coal in one year. It seems to me the very province of this Association to circulate reliable information on such points as these—carefully avoiding, of course, at all times the recommendation of anything untried and experimental. In this way I am convinced that the Association will continue to be a source of wealth to its members, as well as to the surrounding district; and I am desirous that no year should pass without a decided mark of engineering progress being clearly stamped upon by it by the Association. Surface blowing out is now being adopted by several of our members; superheating is being introduced, and steam jackets, so long undervalued, are being revived. I shall take the earliest opportunity of ascertaining full results of their working, and of disseminating this information throughout the entire body of our members."

Fatal Boiler Explosion.—A fatal boiler explosion took place on the night of the 7th ult. at the Byer Moor Colliery, situate at a place called Crookgate, about eight miles west of Newcastle-on-Tyne. The colliery is a new one, the property of Messrs. Bowes, who have several coal-pits in that neighbourhood, and has only been in operation a few months. The boiler that exploded was one of two that were erected on a bed of stone and brick, to the north of the engine-house and pit. The second boiler was undergoing repair, and the boiler-smiths were at work upon it, when, at about half-past four o'clock in the afternoon, the other exploded, causing the death of three persons. The boiler was shattered into four pieces—the sides being flattened with the force of the concussion—three of which were propelled to distances varying from 60 to 100 yards from their original position; and the fourth piece, called the "egg end," was carried in an opposite direction, alighting in a ploughed field. A huge, solid iron ball, called a "damper," was thrown into the air, and in its fall imbedded itself in the ground.

Boiler Explosion.—An explosion, attended with fatal results, took place on the morning of the 13th ult., at a barn owned by Mr. Dunmore, of Stanton Wyville, Leicestershire, where a steam thrashing machine was at work. From the particulars it appears that the engine or boiler was rather out of condition, and that several men, including the engine-driver, were engaged wrapping a pipe that leaked, through which the water was conveyed to the boiler, when suddenly the boiler exploded with a loud report, killing four men on the spot. The boiler was torn to fragments, pieces lying in many and various directions.

ACCIDENTS TO MACHINERY.

Catastrophe at Hartley.—On the 16th ult. the large beam of the pumping engine of the Hartley Colliery pit, suddenly broke in two pieces; one piece, weighing upwards of twenty tons, fell into the pit, and in its fall broke away the "brattice" work, and carried with it bricks, stone, timber, and earth, in tremendous confusion, and so jammed up the pit to the depth of thirty fathoms. The accident occurred just when 215 men and boys, who had been working all night, were about to ascend to make room for the descent of a similar number. In a moment 215 persons were cut off from all communication with the surface, in other words, buried alive. Every effort that science and skill could suggest were made use of to reopen the shaft and succour the sufferers, but unfortunately without success, for when the opening was effected on the 22nd ult., it was found that the 215 men and boys had evidently died three days before from suffocation.

Effects of Frost.—A remarkable instance of the effects of severe frost on iron recently occurred at the Ordnance-wharf, Chatham. During the day a party of convicts were employed in removing a number of the large 10in. guns from one part of the establishment to another in readiness for embarkation. In order to facilitate the operation, the large steam crane was brought into requisition to lift the guns, but scarcely had one of the 10in. guns, weighing 95 cwt., been attached to the gear than the masssive chain which held it suddenly snapped just as the cannon was only a few feet from the ground. What makes the accident appear the more remarkable is the fact that not the slightest flaw could be detected in the metal of which the chain is composed, the chain itself being made to sustain double the weight, and only a few days before having been used in lifting weights of seven tons. At the moment of the gun falling, although several of the convicts were at work within a couple of feet of it, not one was injured.

Colliery Explosion.—On the 18th ult. an explosion took place at the Blackheath Colliery, near Dudley, which was attended with fatal results. In consequence of an accident to the winding engine the work in the mine was partially stopped. A 14 horse-power engine employed in drawing skips out of the deep workings, and in pumping water in the same part of the mine, remained, however, in full operation. On the morning of the 18th ult. a loud explosion was heard at the surface, and immediately afterwards a dense volume of smoke and dust arose from the upcast shaft. Shortly afterwards this was followed by a blaze of fire from one of the shafts, which it was found impossible to extinguish in the ordinary way, the water thrown upon it being at once converted into steam, which reascended the shaft. The flames were, however, ultimately checked by throwing a large quantity of rubbish into the pit. Upon descending, it was found impossible to get at the three men who were below at the time the explosion took place, as the whole mine was on fire. There can be no doubt but they met a speedy death.

DOCKS, HARBOURS, CANALS, &c.

New Lighthouse on the Clyde.—The improvements on the channel of the Clyde between Greenock and Dumbarton, have caused the erection of a new light-house on a perch opposite to Port-Glasgow harbour. The new lighthouse is of iron, circular shape, 11ft. in diameter, and resting on a circular ashlar foundation. The lantern is about 6ft. in diameter and covered by a copper dome, the whole rising about 30ft. above high water mark. It has been lighted with gas, which has been conveyed from Port Glasgow through a pipe sunk at the bottom of the river, and the gas can be turned on and off in Port-Glasgow.

Lights in the Archipelago.—A revolving white light, eclipsed every thirty seconds, has been established on Sigri Island, at the west end of the Island of Mityleni, 180 feet above the level of the sea, and visible twenty-four miles. The illuminating apparatus is dioptric, by lenses of the first order, and the lighthouse stands in lat. 31° 18′ N., lon. 25° 51′ 15″ E. of Greenwich, or about half a mile north, and one mile eastward of the Admiralty charts.—A fixed white light has been established on Ponente Point, the low western point of the Island of Tenedos, fifty-nine feet above the level of the sea, and visible fourteen miles. The illuminating apparatus is dioptric, by lenses of the third order, and the lighthouse stands in lat. 39° 50′ N., lon. 25° 58′ 45″ E. of Greenwich.—A fixed and flashing light, a red flash recurring every two minutes, is shown from a lighthouse on the Isle Gadaro, one mile eastward of the north-east end of Tenedos, fifty-nine feet above the level of the sea, and visible twelve miles. The illuminating apparatus is dioptric, by lenses of the fourth order, and the lighthouse is in lat. 39° 50′ N., lon. 26° 6′ 15″ E.

MINES METALLURGY. &c

Calcining Sulphur Ores.—Some improvements in furnaces for calcining sulphur ores, which are likely to become of importance in the manufacture of sulphuric acid, as they are said to offer a complete solution of the nuisance difficulty in the Swansea copper-works, with the production annually of some £300,000 to £350,000 worth of sulphuric acid, at a merely nominal cost, have been invented by Mr. Peter Spence, of Pendleton Alum Works, Manchester. The inventor has already five furnaces at work in his own business, and four licenses just commencing. Taking Dr. Percy's data as his guide, he declares that he could undertake to calcine all copper ores with about the half of the present expenditure of fuel, and with the conversion of all the sulphur eliminated into sulphuric acid, the only cost of this acid being the nitrate of soda, which, with his furnace, is only half of that regularly used; and, in addition to the interest of the capital invested in vitriol chambers, no labour would be expended on the acid manufacture.

Auriferous Rocks of Victoria.—The area of the quartz bearing rocks at Victoria, in Australia, is estimated at 25,000 square miles. The total area of the extent of land at present mined upon in that colony is 561 square miles. Thus 89,920 square acres have produced gold to the amount of £92,787,236, on an average of about £1,032 per acre, and there yet remains upwards of 15,000,000 acres almost everywhere intersected by quartz veins of greater or less thickness, which are as yet intact by the pick of the miner.

London Coal Trade.—The grand total of coal received in London for the past year is 5,232,082 tons, or a decrease of 6375 tons in sea-borne, and 1322 tons in canal receipts, and an increase of 164,956 tons by railway, as compared with the preceding twelve months.

Mining in Mexico.—The prospectus has appeared of the Capula Mining Company requiring a capital of £50,000, for the purpose of developing a valuable mineral property situated about sixty-five miles north of the city of Mexico. Liberal terms have been offered by the vendor, who, under his arrangement with the promoters, will not be repaid the sum he has expended on the mine until the shareholders have received back the whole of their capital in dividends.

APPLIED CHEMISTRY.

Cæsium and Rubidium.—These are the names of the new metals discovered by spectrum analysis by MM. Bunsen and Kirchoff. The Academy of Sciences has received a communication from M. Grandeau, who states that he has had the advantage of making his researches almost under the eyes of M. Bunsen. M. Grandeau began by examining the various mineral waters and minerals, presenting some analogy with the waters of Durkheim, which have yielded cæsium, and with the lepidolite of Rozena, from which the illustrious chemist of Heidelberg has extracted rubidium. The mother waters of the salt-pits of the basin of the Meurthe, of the Mediterranean, the Ocean, the Dead Sea, and the mineral waters of Bourbonne-les-Bains and Vichy were successively subjected to analysis. Sea water and the salt water of the Meurthe only yielded lithia; that of the Dead Sea lithia and strontian; but the waters of Vichy, of which several thousand litres had to be evaporated, yielded about two grammes of the double chloride of platinum and cæsium, and another of platinum and rubidium, the proportion of which was not ascertained. The quantity of the new metals contained in the waters of Vichy is, therefore, very small; but forty hectolitres of the water of Bourbonne-les-bains yielded, besides chloride of sodium, various calcareous salts and lithia, a considerable quantity of the chlorides of cæsium and rubidium. Some years ago M. Troost had prepared several kilogrammes of salts of lithia, and preserved all the residues. These, examined by M. Grandean, furnished him with a considerable quantity of a mixture of the two metals in nearly equal proportions. The same result was obtained from a lepidolite of Prague, infinitely richer in cæsium than that of Rozena. Lastly, among the artificial productions examined by M. Grandeau, there were the residues of the saltpetre manufactory of Paris. From these Captain Caron had extracted a salt of platinum, in which considerable quantities of the new metals were discovered by M. Grandeau in equal proportions. The refuse of a Belgian saltpetre manufactory contained much rubidium without a trace of cæsium. From all this it would appear that the two new elements are much more widely diffused through nature than was previously suspected.

Resistance of Starch on Cotton Tissue to Solvents.—Chevreul boiled a cotton fabric impregnated with starch in distilled water for two hours, then soaked it in water for two hours, then soaked it in water and hydrochloric acid for eighteen hours, afterwards washed it with common water and then in distilled water; and after all this, the cotton retained enough starch to be coloured blue with iodine.

Coal Tar to Prevent the Potato Disease.—M. Lemaire mixed two per cent. of coal tar with earth, scattered the mixture over his ground, dug it in eight inches deep, and then planted his potatoes. None of those protected by tar showed any sign of the disease, while more than half of some planted at short distance on the same day, and left unprotected, were found to be diseased.

Use of Baryta Salts in Dyeing and Printing.—Frightened at the prospect of manufacturers being some day hard up for potash, M. Kuhlmann proposes to economise its use immediately by substituting baryta salts for the corresponding potash salts employed in dyeing and printing, *e.g.*, the tartrate, chromate, and ferrocyanide. So far he seems to have tried only the tartrate of baryta, which appears to replace tartrate of potash successfully; but M. Kuhlmann is always a little mysterious.

Nitrogen in Meteoric Iron.—The constant presence of nitrogen in ordinary iron led M. Boussingault to look for it in meteoric iron. The specimen he examined fell at Lénarto, in Hungary, and besides the iron and nitrogen, contained the mixture of metals usually found in meteoric stones. M. Boussingault made three very careful analyses, the result of which gave 0·000102 of a gramme of nitrogen in each gramme of the aërolite.

Dianium or Niobium.—Two years ago (*Chemical News*, Vol. ii., p. 143), Von Kobell announced the discovery of a new metal to which he gave the name Dianium. He found the metal, or rather an acid oxide of it, in minerals up to that time supposed to be mainly composed of hyponiobic acid. MM. Deville and Damour have examined some of the same minerals (*Comptes-Rendus*, T. liii. p. 1044) and have to come to the conclusion that what Von. Kobell called dianic acid is only a modification of one of the acids of niobium. This opinion is shared by Hermann. Von Kobell replies, but we fear he must give up dianium.

Simultaneous Action of Air and Ammonia on Copper.—Peligot is well known by his earlier experiments on the ammoniacal salts of copper. Anticipated in some of his results by Schoenbein, he has continued his experiments, and now gives the latest conclusions he has arrived at. He distributes finely-divided copper (obtained by reducing a salt by iron or zinc) about the sides of a large flask, into which he poured a small quantity of very strong ammonia. The vessel soon became warm, and white vapours were seen, which Peligot found to be composed of nitrite of ammonia. On repeating this experiment several times, taking care to refill the flask with air, a blue liquid is obtained. (It is unnecessary to add more copper, as very little is acted on in one experiment; but the points of contact must be changed.) This blue liquid the author found to contain a double nitrite of copper and ammonia. Crystallised and dried in the air, it had the formula NO_3, CuO NH_4O, HO. When boiled, this salt became green, lost its ammonia and water, and there remained anhydrous nitrite of copper, NO_3CuO. The double salt, wrapped in paper, placed on an anvil and struck with a hammer, detonated. When the solution of the double salt is added to water, a turquoise blue precipitate of hydrated oxide of copper is obtained, which enjoys the remarkable property of preserving its colour in the air. It slowly absorbs carbonic acid, and becomes carbonate of copper without changing colour. M. Peligot thinks the same oxide may be cheaply prepared and become an important article in industrial art. The ammoniacal solution of the double salt above mentioned, is said, by the author, to be the best agent for dissolving cellulose, for that substance is precipitated again without alteration on the addition of an acid.

ON THE ACTION OF NITRIC ACID ON PICRAMIC ACID.—BY M. C. LEA.—On this point very conflicting statements have been made. Girard and Pugh respectively state that picric acid is reproduced by the oxydation of picramic acid by nitric acid. A similar statement is made by Kolbe. In a paper published several years since on picric acid, I expressed a similar opinion. On the other hand, Wöhler stated that his nitrohæmatic acid (now known to be identical with picramic) was not reconverted to picric acid by the by the agency of nitric acid. Gerhardt, too, in quoting the first opinion, puts a note of interrogation after it, as if to express a contrary conviction. These differences of opinion have induced me recently to re-examine the subject, and have led to the conclusion that the substance formed is not identical with picric acid. The following were the reactions observed:—Picramic acid readily dissolves in strong nitric acid to a dark brown solution. By fifteen minutes boiling this becomes clear bright red. If then saturated with potash, quantities of nitrate of potash crystallise out, with much brown varnish, but no trace of picrate. After one hour's boiling, the colour of the solution is considerably lighter, the results much the same. After four hour's boiling the colour of the liquid was bright yellow. It was evaporated in the water bath and gave a crystalline substance mixed with much resinous matter. To remove this it was dissolved in as small a quantity of cold water as possible, filtered and mixed with half its bulk of strong sulphuric acid. On cooling, a crystalline reddish yellow substance separated, which might easily be taken for picric acid mixed with resinous impurity. But neutralised by ammonia, and heated with sulphydrate of ammonia, it gave no indications of the presence of picric acid. Tested with cyanide of potassium the results were the same. By spontaneous evaporation of the solution of the substance in ammonia, fan-shaped groups of hair brown needles were obtained. Analysis of these showed conclusively that they consisted of oxalate of ammonia disguised by organic matter. After eight hours' boiling the liquid was pale straw yellow, and by evaporation on the water bath yielded a substance dissimilar from the former, bright yellow, and coloured intensely deep red by cyanide of potassium after previous supersaturation with ammonia. But treated with sulphydrate of ammonia, it gave no indications of the production of blood red picramite, but became greenish brown, with production of a greenish precipitate. The presence of oxalic acid could not be detected. These experiments appear to me to leave no doubt that picric acid is not formed by the action, either brief or prolonged, of nitric acid on picramic acid, but that resinous substances are produced, accompanied after a time by oxalic acid, which at a later stage suffers decomposition itself. All these substances are, however, produced in very small amount, the greater part of the constituents of the picric acid passing off in volatile decomposition products.

APPLICATIONS FOR LETTERS PATENT.

Dated December 27, 1861.

3238. W. Hawksworth, Oldham—Engines.
3239. T. Silver, Philadelphia, U.S.—Governing or regulating the speed of steam and other engines.
3240. W. Turner and J. W. Gibson, Dublin—Rolling bridges.
3241. P. Armand, 4, South-street, Finsbury—Treating fatty and resinous bodies either in a neutral or acid state.
3242. T. Bright, Carmarthen—Machinery for cutting hay, straw, and other vegetable substances.
3243. T. W. Atlee, Birmingham—Cocks or taps for drawing off fluids.
3244. W. E. Newton, 66, Chancery-lane—Steam generators.
3245. J. McIntyre, New York—Bomb shells and similar projectiles.
3246. R. A. Brooman, 166, Fleet-street—Steam generators, and fire-bars employed therein.
3247. J. J. H. Fajole and P. A. Agostini, Courbevoie—Improved compositions suitable for painting, varnishing, and coating.

Dated December 28, 1861.

3248. J. W. Harland, Chorlton-on-Medlock—Manufacture of wood and other types or substitutes therefor, or furniture used by letter-press printers.
3249. E. Lord, Todmorden — Machinery for preparing cotton and other fibrous substances.
3250. A. Warner, Threadneedle-street—Hollow articles for military and war purposes.
3251. M. Henry, 84, Fleet-street—Fire-arms, and adapting bayonets or cutting or piercing weapons thereto.

Dated December 30, 1861.

3252. J. P. Dormay, J. S. Aikenhead, and T. Johnson, Wandsworth—Boats for sailing or rowing.
3253. J. Edwards, 77, Aldermanbury—Permanent way of railways.
3254. F. Tolhausen, Paris—Machines for reaping, gathering, and binding harvest produce.
3255. J. Gorton, and B. Henderson, Gateshead—Ropes.
3256. G. H. Birkbeck, 34, Southampton-buildings—Apparatus for raising or forcing water or other fluids.
3257. W. E. Newton, Chancery-lane—Cube sugar.
3258. J. B. Payne, Chard—Improved machinery for the manufacture of laid and other twine, lines, ropes, bands, and other cordage, whether made of hemp, flax, or other fibrous substances, or of wire.
3259. A. I. Austen, Millwall—Night lights.

Dated December 31, 1861.

3260. W. Tongue, Brixton—Certain descriptions of woven, looped, and bobbin net fabrics by the application of certain fibrous materials thereto.
3261. A. Macnair, 34, Southampton Buildings, Chancery-lane—Axle boxes for railway carriages.
3262. W. Tongue, Brixton—Umbrellas and parasols.
3263. T. Green, W. Green, and R. Mathers, Leeds—Chains for giving motion to chain wheels, and giving motion to machinery.
3264. N. McHaffie, Glasgow—Ventilators or valves for regulating the passage of air or other fluids, whether of a gaseous or liquid form.
3265. T. Pickford, Fenchurch-street—Manure.
3266. F. Tolhausen, Paris—New method and machinery for covering springs used for petticoats and other articles.
3267. W. Spence, 50, Chancery-lane—Reflectors for lamps.
3268. J. Haslam, Preston, Lancashire—Apparatus for winding, holding, and letting go cords, bands, or chains.
3269. W. H. Bailey, Salford, Lancashire—Sewing machines.
3270. W. E. Newton, 66, Chancery-lane—Apparatus for obtaining motive power from explosive compounds.
3271. W. E. Newton, 66, Chancery-lane—Apparatus for boring rocks and other mineral substances.
3272. E. Tiphagne, Paris, and D. Delbosque, Nogent-sur-Marne—Advertisements.
3273. J. B. Cretal, Saint Malo, France—A new process of colouring smoking pipes.
3274. E. T. Hughes, 123, Chancery-lane—Saddles.
3275. R. A. Brooman, 166, Fleet-street—Revivifying animal black or charcoal, collecting ammoniacal gases generated in the revivification, the clarification of saccharine liquors, and apparatus employed in the revivification of the black, and filtering of saccharine liquors.
3276. A. Edward and J. Edward, Dundee—Machinery and apparatus for spinning fibrous materials.

Dated January 1, 1862.

1. J. M. Rowan, Glasgow—Railway wheels, and apparatus to be used therein.
2. N. C. Szerelmey, Brixton—Manufacture of leather cloth or imitation leather, and rendering certain fabrics waterproof.
3. J. H. Johnson, 47, Lincoln's-inn-fields—Hose pipe joints or couplings.
4. T. Hall, Odiham, Hampshire—Removing weeds from canals, rivers, and lakes, after such weeds have been cut with a chain scythe or other machine or implement applicable to that purpose.
5. J. Walker, 25, City-road—Forts and fortifications which are applicable to floating batteries.
6. T. C. Clarke, Liverpool—Apparatus for heating and circulating water and other liquids.
7. J. Bradbury, Pendleton, Lancashire—Self-acting mules.
8. R. A. Brooman, 166, Fleet-street—Shears or scissors.
9. R. A. Brooman, 166, Fleet-street—Supporting and propelling vessels.
10. W. Bush, Tower Hill—Omnibuses and other carriages.
11. B. Rhodes, Old Ford, Bow—Forming straight and bent pipes and bends for pipes, and also vessels of various shapes, and coating and protecting objects and articles of various forms intended to be employed for various purposes.
12. E. Banfield, Ilfracombe, Devonshire—Lubricating and maintaining in working order axle journals and brasses applicable also to other journals and bearings.
13. W. B. Patrick, Highgate—Manufacture of sugar, and the apparatus employed therein.
14. E. F. Davis, Tavistock-square—Gas burners.
15. J. Howard and E. T. Bousfield, Bedford—Apparatus applicable to steam cultivation.
16. W. E. Newton, 66, Chancery-lane—Coffee pots and boilers for culinary purposes, also applicable for generating steam.
17. J. J. Gutknecht, Zigers, Switzerland—Meters for measuring gas, water, and other fluids, under any pressure, even the smallest, without making any change in the apparatus.

Dated January 2, 1862.

18. W. E. Gedge, 11, Wellington-street, Strand—Apparatus for roasting coffee.
19. A. M. P. Airiau, Paris—Musical instrument called "lute organ."
20. W. A. Fell, Windermere—Bobbins, and the means or apparatus employed therein.
21. M. Cartwright, Carlisle—Models, and "plates" or "pieces" for artificial teeth.
22. G. Jeffries, Norwich—Breech-loading fire-arms, and apparatus for the manufacture of cartridges.
23. H. Eschwege, 14, Mincing-lane—Treating woad and other vegetable spirit.

Dated January 3, 1862.

24. E. Nugent, Brooklyn, United States—Fire-arms.
25. G. Stracey, Norwich—Improvement in artificial fuel.
26. F. S. Belloche and H. Bollack, Paris—Parasol.
27. W. E. Gedge, Wellington-street, Strand—Apparatus for dressing, cleaning, or sifting grain.

Dated January 4, 1862.

28. J. W. Arundell, 265, Gresham House, Old Broad-street—Improved apparatus for treating and dressing ores and minerals, particularly applicable to tin, lead, copper, zinc, and iron ores.
29. J. W. Arundell, 265, Gresham House, Old Broad-street—Improved apparatus for removing impurities from coal, parts of which invention are applicable for the separation and cleansing of ores and other minerals.
30. J. W. Arundell, 265, Gresham House, Old Broad-street—Communicating motion to fan ventilators, particularly applicable to ventilating mines.
31. C. Cross, and E. Padmore, Manchester—Piled fabrics and machinery or apparatus employed therein.
32. R. H. Cotter, Cambridge Heath—Apparatus for suddenly producing a permanent light.
33. G. Leyshon, Tividale, and D. Beckly, Brockmoor—Breaks for retarding and stopping carriages on railways.
34. J. Howden, Glasgow—Steam engines and boilers.
35. H. D. Pochin, Salford—Soap or size.
36. G. T. Bousfield, Brixton—Machinery for propelling water craft.
37. A. Warner, 31, Threadneedle-street—Preparing materials for and purifying coal gas.

Dated January 6, 1862.

38. J. Coryton, 89, Chancery-lane—Type machine.
39. A. V. Newton, 66, Chancery-lane—Manufacture of cigars.
40. G., G. W., and J. Betjemann, Pentonville—Dressing cases, applicable to other cases and boxes.
41. P. B. O'Neill, Hart-street—Screw wrenches or spanners.
42. W. T. Kite, Wallingford—Manufacture of starch, and apparatus employed therein.
43. F. Brown—Kitchen ranges and cooking apparatus.

Dated January 7, 1862.

44. F. Shaw, Sheffield—System of stopping railway trains.
45. J. Higgins and T. S. Whitworth, Salford—Machinery for spinning and doubling cotton and other fibrous materials.
46. J. Tatham, Rochdale—Machinery for preparing, spinning, and doubling cotton and other fibrous materials.
47. B. Foster, Denholme Mills, Yorkshire—Machinery for spinning and doubling wool and other fibrous materials.
48. A. Wallis and C. Haslam, Basingstoke—Rotary screens.

Dated January 8, 1862.

49. D. Beale, Bromley—Fastening iron plates to ships' sides.
50. L. Wunder, Liegnitz, Prussia—Manufacture and composition of soap.
51. A. Heath, 12, Union-square, Islington—Inkstands.
52. S. Jesson, J. Batson, the younger, J. Moore, the younger, and J. Roberts, Smethwick—Gun barrels and wrought-iron tubing.
53. C. and T. Pilkington, Sheffield—Skates.
54. J. Barber, Preston—Hand mules, consisting of a break and backing off motion.
55. J. Stenhouse, 11, Upper Brunswick-terrace, Barnsbury-road—Rendering certain substances less pervious to air and liquids.
56. H. Bessemer, New Cannon-street—Machinery employed in the manufacture of malleable iron and steel.
57. W. Bradshaw, the younger, Coventry—Watches.
58. H. Cook, Manchester—Apparatus for propelling by the agency of electricity.

Dated January 9, 1862.

59. C. W. Siemens, 3, Great George-street—Means and apparatus employed for insulating and protecting telegraph conducting wires, and in apparatus for working the same.
60. J. Smith and S. Wellstood, Glasgow—Cooking stoves or ranges.
61. J. Brunt, Paris—Gas meters.
62. T. A. Weston, Birmingham—Multiplying gearing for transmitting and multiplying power, which said gearing may be applied to cranes, windlasses, capstans, and presses, and to other purposes where it is required to transmit and multiply power.
63. D. Wilson, Ceylon—Machinery for pulping and preparing coffee.
64. H. Charvet, Lille—Spinning of cotton and its various applications.
65. D. Wilson, Ceylon—Hydraulic presses.
66. J. H. Tatum and W. J. Williams, Bridge-street—Manufacture and structure of wicks, and the application of the same to the manufacture of candles.
67. R. A. Brooman, 166, Fleet-street—Apparatus for carburetting and burning gas.
68. B. Thompson, Birmingham—Ordnance and fire arms, and projectiles to be used therewith.
69. H. Barber, Belgrave, Leicester—Safety lamps.

Dated January 10, 1862.

70. A. R. Le Mire de Normandy, King's-road, Clapham-park—Fixing tubes in tube plates.
71. J. Carter, Tipton—Draining plough.
72. R. Johnson, Liverpool—Composition for coating the bottom of iron ships to prevent their fouling, and other purposes.
73. M. Wigzell, Topsham—Double acting ventilator for railway carriages and other carriages and compartments.
74. F. Moores, Warrington—Obtaining motive power.
75. J. Oates, Mirfield—Washing machines.
76. H. Darvill, New Windsor—Hardening of chalk for building purposes.

77. W. H. Preece, Southampton—Apparatus for signalling upon railways.
78. L. Petre and E. S. S. Tucker, 194, Waterloo-road—Application of velvet, plush, leather, American cloth, oil cloth, and other suchlike substances alone and in combination with other materials for advertising boards, show cards, window tickets, and all such uses.
79. J. Kenyon, Hampstead, and A. Horn, Bedford-row—Railway signalling by electricity, and the arrangement of apparatus for that purpose.
80. W. Clark, 53, Chancery-lane—Apparatus for generating and applying steam as a motive power.

Dated January 11, 1862.

81. T. Ramsay, Newcastle-upon-Tyne—Manufacture of coke.
82. H. Charlton, Birmingham—Certain kinds of shoes for mules and horses.
83. J. White, Southwark—Lubricating or oil cans, or oil feeders, and the mechanical arrangements for regulating the flow of oil therefrom.
84. L. Mackirdy, Greenock—Reburning animal charcoal.
85. T. Scott, Nelson-square—Steam engines.
86. W. Wilkinson, Bayswater—Ornamenting and decorating metals, glass, porcelain, parchment, and other skins, and the materials and ingredients employed therefor, also protecting silver and gold on said materials, and on surfaces or plates of glass or metal, or plates of glass and metal combined, applicable to works of art, furniture, jewellery, and other articles of a useful and ornamental character.

Dated January 13, 1862.

87. A. G. Southby, Bulford—Pulp for paper making.
88. J. M. Rowan, Glasgow—Manufacture of iron and steel.
89. T. Gilbert, C. Gilbert, and T. Haddon, Birmingham—Manufacture of swivels for guns, and machinery to be employed in the said manufacture.
90. F. C. Warlich, 10, Alma-Terrace, New-cross—Artificial fuel.
91. T. Soar, Nottingham, J. Belshaw, Radford, and M. Soar, Nottingham—Knocker to be attached to doors, shutters, or other parts of premises to which the same may be applicable, and applicable also for the reception of letters and other documents.
92. J. Parker, Bradford, and J. Wells and B. Wells, Bowling—Steam engines, boilers, furnaces, and apparatus in connection therewith or applicable thereto.
93. W. E. Gedge, 11, Wellington-street, Strand—Apparatus for gaining or acquiring motive power.
94. R. A. Brooman, 166, Fleet-street—Cups, bowls, saucers, and other dished articles and cases.
95. H. Schottlander, Paris—Albums for containing photographic and other pictures.
96. G. Hewitt, Ipswich—Apparatus used in the manufacture of drain tiles.
97. J. Betteley, Liverpool—Ship building.
98. T. W. G. Treeby, Paddington—Cannon and fire-arms.
99. J. G. Marshall, Leeds—Preparation of flax and other fibres pervious to being spun.
100. C. N. May, Devizes—Manufacture of pastry, and apparatus for the same.

Dated January 14, 1862.

101. J. Carter, Chelsea—Shaft tug or bearer used in harness.
102. E. W. Hughes, 22, Parliament-street, Westminster—Engineering and architectural structures.
103. J. Paine, Manchester—Printing and ornamenting kamptulicon when applied to fabrics.
104. J. Jack, Liverpool—Cores for moulding or shaping metals.
105. M. Chadwick, Radcliffe, Lancaster—Machinery for folding or platting cloth and for measuring the same.
106. W. Gores, Minworth—Machinery for manufacturing the cut nails called brads.
107. S. W. Marsh, Washington, U.S.—Breech loading fire-arms.
108. T. Harrison, Birmingham, and J. G. Harrison, Kirby Ravensworth—Ploughs.
109. C. Hill, Kidwelly—Lubricating compounds.
110. J. Harris, Newton Abbot—Semaphore target marker.
111. J. G. Marshall, Leeds—Machinery and processes for producing the fibre from woven and other textile fabrics.

Dated January 15, 1862.

112. E. Lord, Todmorden—Looms for weaving.
113. W. Cleland, Everton, Liverpool—Treating and utilizing certain materials used and products obtained in the manufacture of gas, and apparatus connected with the said treatment.
114. T. Timmins and T. Simmons, Birmingham—Combination bath.
115. J. Ridsdale, Minories—Preparing sheet lead for covering floors, stairs, and other like purposes.
116. H. D. P. Cunningham, Bury, Hants—Means for protecting screw propellers from entanglement or being fouled by ropes or other bodies, also improvements in means for closing up the screw aperture.

Dated January 16, 1862.

117. J. Brooke, Leeds—Form of lubricators.
118. J. A. Knight, 4, Symonds-inn, Chancery-lane—Application of a diamond cutter and improved machinery for dressing millstones.
119. E. H. C. Monckton, Fineshade—Apparatus for obtaining and applying motive power.
120. T. Matanle, Bethnal-green-road—Improved runner fastening for umbrellas, parasols, sunshades, and other similar articles.
121. W. Tristram, Bolton—Power looms for weaving.
122. H. Wheatcroft, 27, Fore-street—Bonnet and cap fronts and similar fabrics.

Dated January 17, 1862.

123. T. Myers, 41, Bloomsbury-square, and E. Myers, 56, Millbank-street, Westminster—Preventing rust on bright steel, iron, brass, or metal surfaces.
124. R. Dunlop, Cwm Avon Taibach, Glamorgan—Means for facilitating calculations.
125. J. M. Rowan, Glasgow—Construction of steam hammers.
126. B. Moss, Liverpool—The application for certain material or a mixture of such material with clay or substances, and for the manufacture therefrom of bricks, fire blocks, and so forth, applicable to the construction of iron furnaces, copper smelting furnaces, and other metallurgical operations, glass house sieges for pots, and glass houses, and for the linings of furnaces, also for the manufacture of crucibles for the melting of brass and other purposes.
127. N. Thompson, Camden-town—Apparatus for stopping bottles.
128. J. C. Dickey, Saratoga Springs—Improved quartz crusher.
129. R. Romaine, Devizes—Apparatus to be used in cultivating land by steam power, and steam boilers used for agricultural and traction purposes.

Dated January 18, 1862.

130. John Tow, Oxford-street—Construction of stoves or fire-places.
131. T. Emmott and J. Travis, Oldham—Manufacture of velvets, velveteens, and other similar piled fabrics.
132. T. Newton, Manchester—Sights for rifles.
133. E. Davies, Warrington—Apparatus for gauging and cutting soap.
134. W. Helme, Caldbeck—Fire-lighter.
135. J. J. Stevens, Southwark—Point indicators for railways.
136. W. Tice, Islington—Gas regulators and other apparatus in which moveable spindles are employed.
137. S. Dreyfous, Paris—Throstle spinning frame.
138. W. L. Winans, Baltimore—Manner of mounting and apparatus for manœuvring cannon or ordnance on ships or vessels of war and floating batteries.
139. T. Roberts and J. Dale, Manchester—Gunpowder.

Dated January 20, 1862.

140. W. S. Mappin. Birmingham—Improved lock.
141. L. Barbat, Paris—Improvements in the manufacture of hats and bonnets.
142. T. Holt, Edward-street, Blackfriars—Folding iron chairs and chair bedsteads.
143. T. W. Jobling, Point Pleasant, Northumberland—Adaption of locomotive engines to traction or haulage in mines.
144. W. Boaler, Manchester—Method of sizing paper yarns and woven fabrics, and machinery or apparatus connected therewith.
145. A. Lamb, Southampton, and J. White, West Cowes—Life boats.
146. J. Bird, Blidworth—Crank axle applicable to cranks of any description whatsoever wherein the wear is mainly on one side thereof.
147. E. C. Nicholson, Locks-fields—Preparation of colours suitable for dyeing and printing.
148. J. W. Agnew, London, West Canada—Adjusting last.
149. R. O. Doremus and B. L. Budd, New York, U.S.—Making cartridges.

Dated January 21, 1862.

150. J. Stenhouse, Barnsbury-road, Middlesex—Protection of metallic surfaces, and rendering certain substances less pervious to air and moisture.
151. J. A. Knight, Chancery-lane—Permanent way of railways.
152. J. F. Tourrier, Manchester-square—The diffusion of heat in houses by means of hot air without extra fire.
153. C. Binks, Gray's-inn—Generating steam, superheating steam, and apparatus employed therein.
154. J. Bate, Birmingham—Machines for corking or stopping the mouth of bottles, jars, or any vessel requiring to be stopped up air-tight.
155. H. B. Barlow, Manchester—Machinery for counting and indicating the number of revolutions of shafts or other articles, and for exerting power.
156. G. T. Bousfield, Brixton—Machinery for making nails and spikes.
157. J. H. Rawlins, Wrexham—Machinery used in the manufacture of paper.
158. A. J. Martin, Bow—Treatment of fusel oil, and for various applications of the same to useful purposes.
159. R. A. Brooman, 166, Fleet-street—Street and road sweeping machines, parts of which are applicable to the separation of liquid from solid substances.
160. W. Burgess, Newgate-street—Reaping and mowing machines.
161. M. Henry, 84, Fleet-street—Mode of and apparatus for applying electricity to horology.
162. W. Tozer, Gracechurch-street, and A. Read, Walworth—Boots and shoes.

Dated January 22, 1862.

163. L. Martin, Paris—Treatment of mineral oils, and the apparatus connected therewith.
164. I. Roberts, Liverpool—Combined hydraulic motive power engines and meters.
165. F. W. Gerish, East-road, City-road—Printing presses.
166. E. Pace, Queen-street—Laths for Venetian blinds, painting such laths, and raising and lowering Venetian blinds.
167. A. J. Beer, Canterbury—Valves of steam and other motive engines.
168. T. Little and J. Little, Alston—Apparatus for cooling coffee berries.

Dated January 23, 1862.

169. J. Hinks and A. Dixon, Birmingham—Apparatus for warming and drying boots, shoes, or slippers, to be called a "boot warmer."
170. J. A. Mays, No. 30, Regent-square—Envelopes and other wrappers.
171. J. Tomlinson, Liverpool—Washing machines.
172. J. Wallace, Alexandria, Dumbarton—Reaping machines.
173. F. W. Werner, Mannheim—Apparatus for the destruction of vermin.
174. W. H. Ropes, Old Broad-street—Machinery for cleaning coffee, rice, or any seed or grain, having an outer hull and inner pellicle.
175. H. Owen, Albert Terrace, Islington—Manufacture of stockings and other articles of hosiery.
176. G. Rogers, Staines—Mechanical arrangements for letting-off water or other liquids from butts, vessels, or cisterns.
177. J. C. Johnson, Nottingham—Manufacture of twist lace in twist lace machines.
178. A. Ripley, Lambeth—Construction of pistons.
179. H. Yates, Cecil-street, Strand—Machinery for bending, repairing, or renewing defective or damaged parts of iron rails.
180. J. G. Service, Glasgow—Machinery for cutting and scoring pasteboard and other similar material.

Dated January 24, 1862.

181. A. W. Williamson, University College, London—tubulous boilers or steam generators.
182. J. Higgin, Manchester—Machinery for retarding and stopping railway carriages.
183. J. Cornforth and B. Smith, Birmingham—New or improved machinery for boring or drilling gun-barrels and tubes and other articles having a cylindrical or prismatic figure, which said machinery may also be applied to other like purposes.
184. W. Clark, 53, Chancery-lane—Manufacture of artificial flowers, leaves, and fruit.
185. J. Longhurst, Ticehurst, Sussex—Chains and chain cables.
186. J. Rock, jun., Hastings—Common road carriages.
187. J. W. Girdlestone, Birkenhead—Projectiles for fire-arms.
188. T. Morris and R. Weare, Birmingham, and E. H. C. Monckton, Fineshade, Northampton—Submarine and other telegraphic communication, and apparatus connected there with.
189. C. G. Hall, Regent-street—Boots, shoes, and leggings.
190. A. Wallis and C. Haslam, Basingstoke—Thrasing machines.
191. J. Alison, Brightland, Reigate—Apparatus for tilling land by steam power.

Dated January 25, 1862.

192. W. Baker, Downham—Fire arms.
193. W. Johnston, Glasgow—Lamps.
194. C. West, London—Insulting and covering wire, and the preparation of the materials for insulating.
195. J. C. F. Mougin, Paris—Barcelonnettes or cradles for children or for dolls.
196. J. H. Johnson, 47, Lincoln's-inn-fields—Prevention or removal of incrustation in or from steam generators, and the apparatus employed therein.
197. D. Edleston and H. Gledhill, Halifax, York—Means and apparatus for finishing textile and other fabrics.
198. E. A. Curley, Clerkenwell—Sewing machines.
199. J. Wright, Rochester—Constructing works below water.
200. F. J. L. Lefort, Bothey, Belgium—Mechanical arrangements constituting a secret and invisible safety lock applicable to iron safes and other depositories.
201. F. Roberts, Maiden Newton, and A. Roberts, Frome Vauchurch—Apparatus for ploughing or cultivating land.
202. J. Brown and J. Davenport, Bolton—Lubricator for pistons.
203. A. Samuelson, 28, Cornhill—Hydraulic presses, and the mode of working the same.

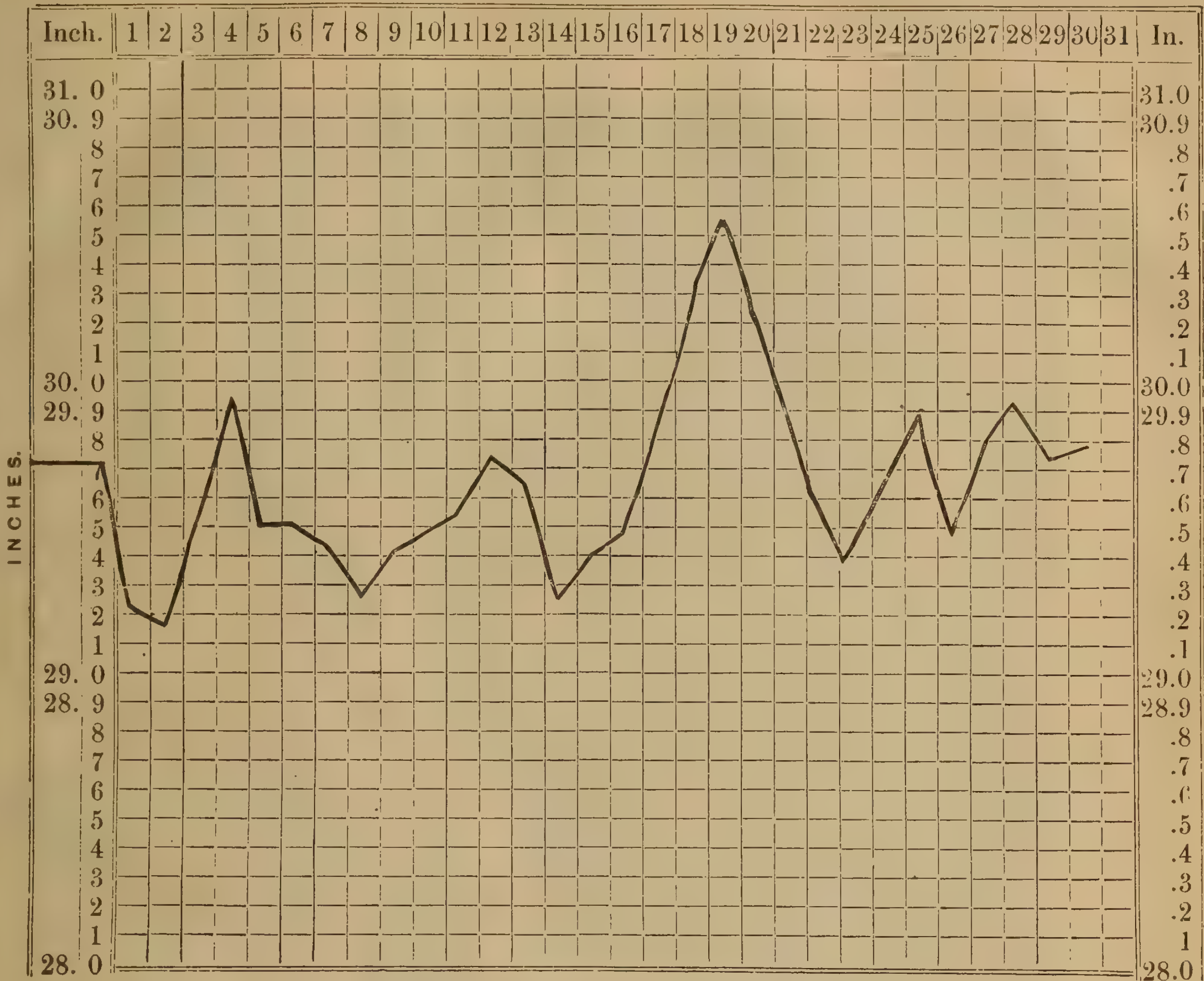
Dated January 27, 1862.

204. W. Smith, Manchester, and C. Tiesset, Boulogne-sur-Mer—Colours for dyeing and printing.
205. J. Lillie, Duke-street, Adelphi—Application of new materials to the bottoms of sea-going and other vessels for the prevention of fouling.
206. S. A. Carpenter, Birmingham—Covering and combining strips or bands of steel for crinoline or crinoline skirts.
207. R. Martindale, Handsworth, Staffordshire—Globes and glasses to be used with hydro-carbon lamps.
208. C. W. Harrison, Lorimer-road, Walworth—Printing, stamping, embossing, perforating, and other like operations, and the machinery or apparatus employed therein.
209. W. Orr, Greenock—Machinery for the manufacture of sugar.
210. J. Smith, Keighley, Yorkshire—Construction of covered rollers used in machinery for preparing, roving, spinning twisting, and doubling fibrous materials.
211. W. W. Warren, Gravesend—Preventing the desecration of the dead for sanitary purposes, and providing a cheap and inexpensive mode of interment.
212. T. J. Robotham, Burslem, and N. Hackney, Hanley—Purifying slip, glaze, and other potters' materials.

ROYAL NATIONAL LIFE BOAT INSTITUTION.

Reading of the Barometer for the Month of November, 1861.

DAYS OF THE MONTH.



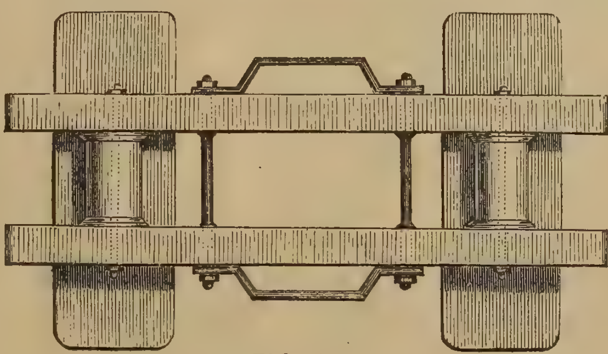


FIG. 1.

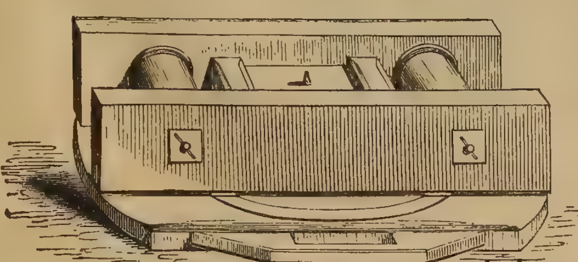


FIG. 3.

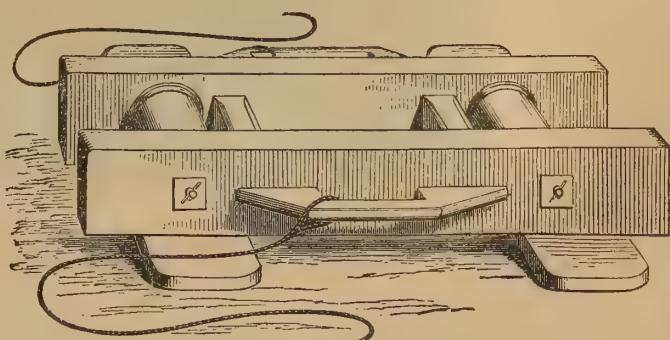
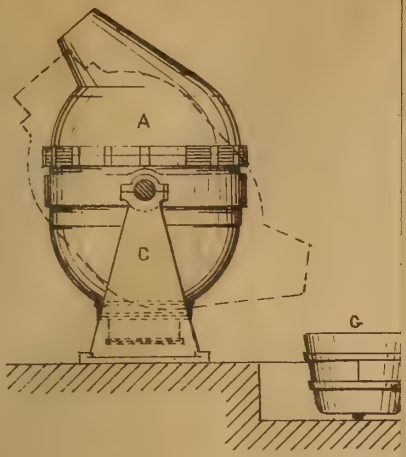


FIG. 2.

THE RAMSGATE LIFE-BOAT.

A NIGHT ON THE GOODWIN SANDS.

MER.



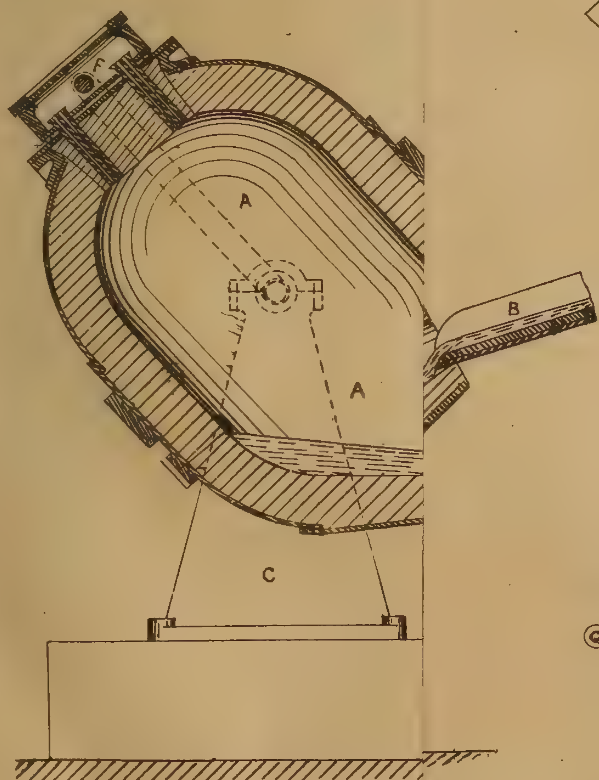
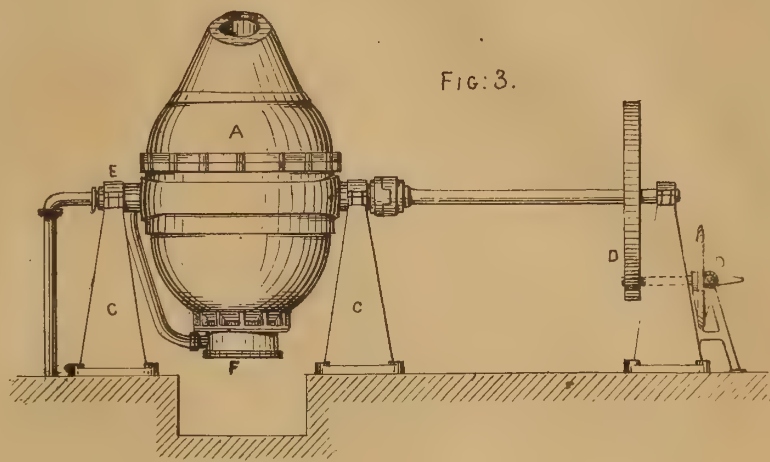
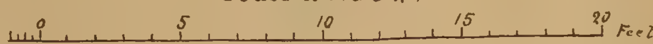


FIG: 3.



Scale to FIG 3 & 4.



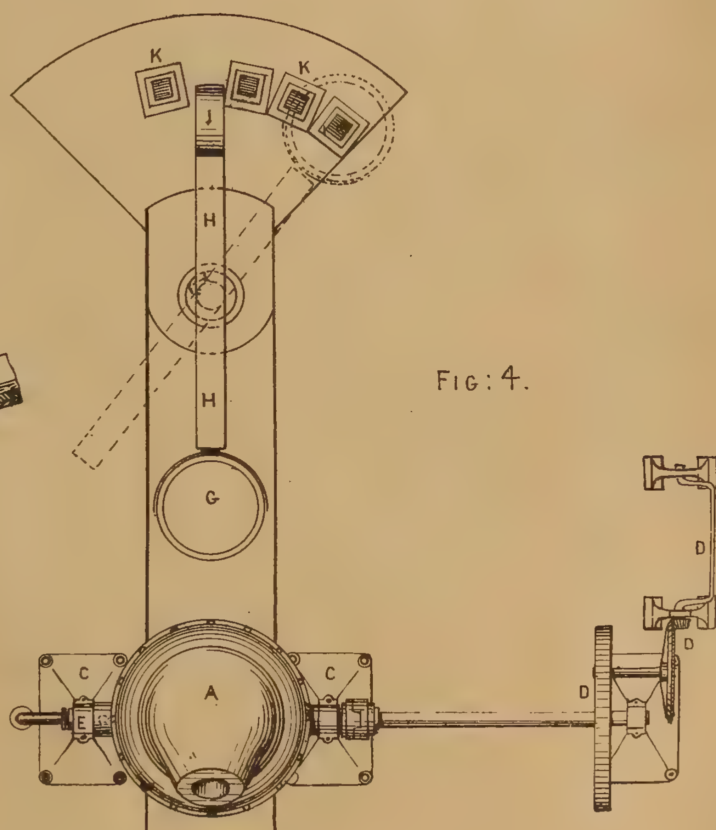
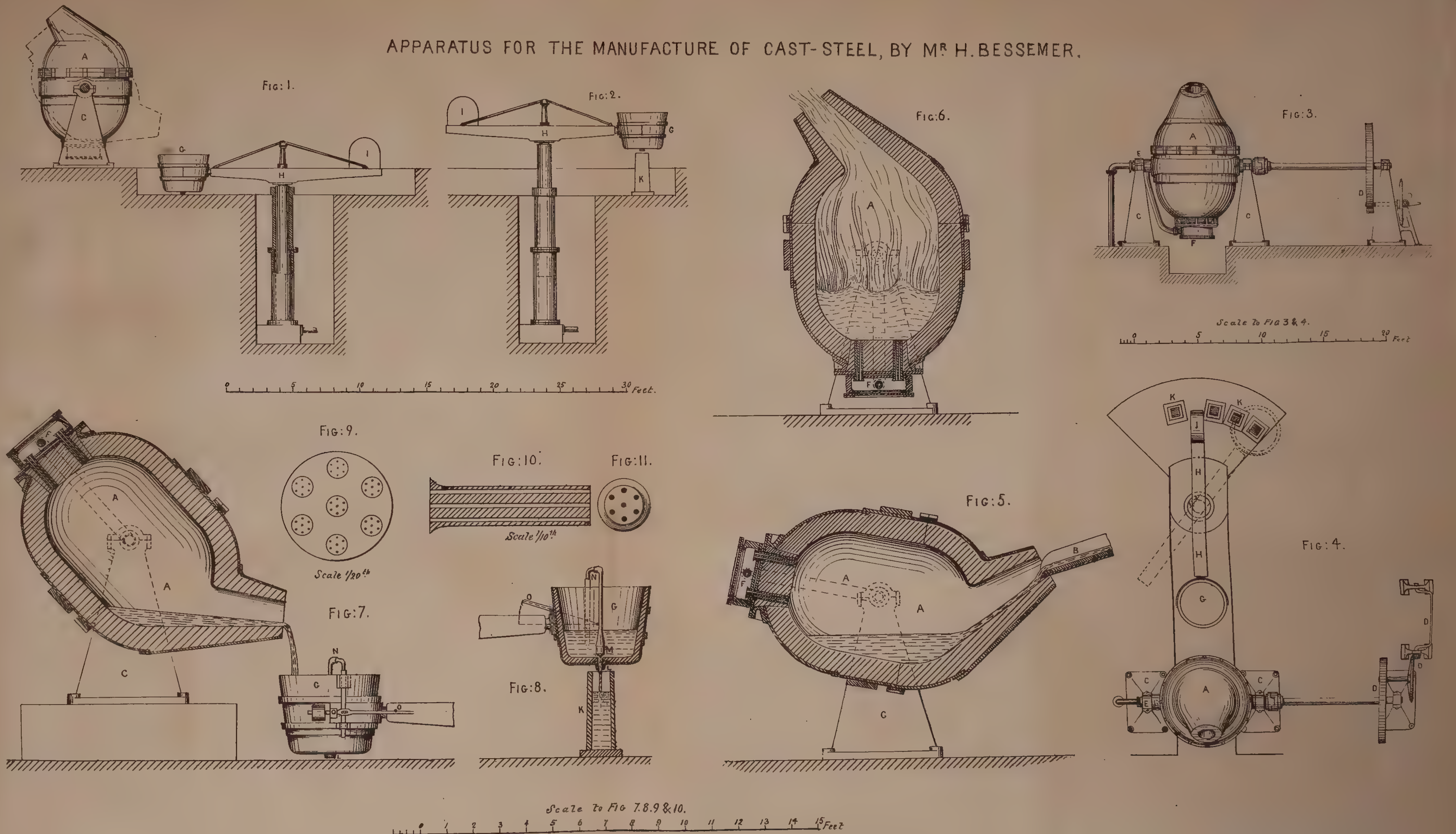


FIG: 4.

W. Smith C.E. direx.

APPARATUS FOR THE MANUFACTURE OF CAST-STEEL, BY MR H. BESSEMER.



W. Smith C.E. direx.

THE ARTIZAN.

No. 231.—Vol. 20.—MARCH 1, 1862.

ON SUBSTITUTES FOR RAGS IN PAPER MAKING.

During the last five or six years the paper manufacture has been in an extraordinary state of, if we may use such an expression, disturbed equilibrium. First came a sort of furore for the discovery of some material to take the place of rags, the supply of which, it was believed, was fast becoming insufficient to meet the constantly increasing demand. After that set in the agitation in connection with the repeal of the duty upon paper; and so the whole trade has been kept in a state of uncertainty to the present moment.

With respect to the discovery of new materials of a fibrous character, fit for papermaking, a great deal has been written and said, and a vast amount of time spent, we may say wasted, in investigations, which would never have been the case had the authors, and speakers, and experimentors possessed any real knowledge of the requirements of the paper-maker. And so slight has been the advancement made by virtue of all these exertions, that the question remains practically very much where it was at the beginning; indeed, none but the experienced manufacturer knows how very difficult this problem is, and how very little progress has been made towards its solution. It is a popular idea that any fibrous material from which a sheet of paper can be made may be applied to the uses of the papermaker; there can be no greater fallacy; almost any vegetable material can, in fact, be converted into paper, there are scores of substances which can be readily bleached, beaten into pulp, and converted into good, some into excellent, paper. But there are many things to be thought of besides this, and it is really going but a very little way into the actual question of the substitution of other materials for rags in a commercial sense. The real gist of this question lies in the implication that any material to substitute rags must produce paper equal to that from rags at less, or at least not greater cost. The new material must yield paper equally good with rag paper, and costing no more. This being the question, is there any material which can be said to, in any wise, take the place of rags in paper making? At present there is none. Although almost every conceivable fibrous substance has been the subject of experiment, and most of them of patent, in relation to paper, and although numberless ingenious and active minds are ever at work upon this object, there is not, at the present time, any new raw material employed in paper making, with the exception of straw, and perhaps a comparatively small quantity of the Esparto, or Spanish grass; and with respect to straw the use is almost wholly exceptional, as the paper can scarcely be ranked with rag paper. In applying any of these prepared fibrous materials to the manufacture of paper in competition with rags, there are many important points for consideration. In the first place (and this forms a sort of standard to which the question must constantly be referred), rags are a refuse material; throughout the civilised world rags are produced spontaneously, as it were, with as much certainty as time passes away; it requires neither capital nor industry; neither sowing nor reaping; neither sunshine nor rain, to produce rags; changes of season, commercial crises do not interfere with their production; within narrow limits, therefore, the supply is certain and invariable. Add to this that rags are a material already prepared to the hand of the paper maker, they have already undergone treatment which must be applied in a greater or less degree to all fibrous substances before they can be fitted for his use, and that, above all, rags are perfectly suited to the object in question, so that, irrespective of cost and trouble of manufacture, no substance has been discovered capable of producing paper equal in all respects to that made from rags. The fact that rags are refuse material places a difficulty, *in limine*, with respect to the introduction o raw material, properly so called, to take their place. Raw material must be raised by cultivation, which requires labour and capital; it must be dependent upon the character of the seasons, and upon a hundred circumstances which will affect the certainty of the supply, and enhance the cost—that is the first cost. Coming then to the paper maker, it requires to be treated by peculiar methods irrespective of paper making but necessary to reduce the crude material to a manageable form; and then comes lastly the comparison between the new substance and rags, in facility of working and in the quality of paper produced.

It is generally believed that linen enters much more largely into the composition of fine paper than is really the case. Cotton is by far the more staple commodity and constitutes probably at least four fifths of the best papers. The fibre of cotton is remarkably adapted to the production of a fabric like paper, in which the strength is wholly due to a natural interlacing of the fibres similar to what exists in felt. Examined under the microscope, it will be seen that the fibres in paper run in every possible direction, intertwining and winding about each other so as to give firm consistency and considerable strength. It is not every kind of vegetable fibre which posses the property of interlacing together in this manner, and paper made from fibres deficient in this property can never be equal to paper made from linen and cotton, which do possess it pre-eminently. The fibre from many vegetable substances is almost straight, the fibres laying together naturally in fasiculi or bundles, and devoid of the curling property by which the fibres are enabled to twist themselves together when the natural structure is broken down—such matters will never make a good tenacious paper. Other fibrous materials are naturally endued with, that is cemented together by, or encased in, substances which must be wholly removed before the paper maker can avail himself of their otherwise valuable qualities; in flax, for instance, the fibre is encased in a coating of siliceous matter which, when the structure of the plant is broken down, developes itself in what is technically called shive. In preparing flax for textile purposes the shive is removed by various processes, the value of the material being sufficient to justify the outlay; but if the same outlay were incurred upon raw flax for the uses of the paper maker, the value of flax thus prepared would exceed that of the best linen rags; and this brings us back to the starting point, that all new materials have to contend with a refuse material in paper making.

It would be a vain and humiliating thing to say that as knowledge advances, no substitute can be found to take the place of rags in the paper mill. In all probability the reverse will be the case, and the time will come when cheap and appropriate substances will be produced, affording to the paper maker a regular and economical supply of raw material, as suitable to his use as rags now are; but there are many things to be considered before it can be assumed that any substance, simply because it is found by experiment capable of being converted into paper, will become a competitor with rags on the commercial scale.

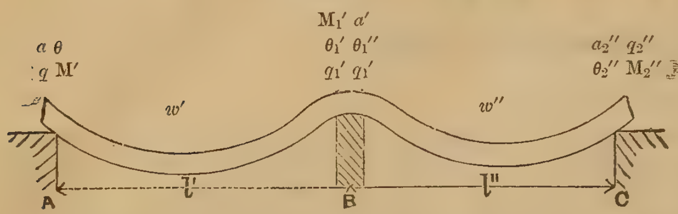
It will be remembered by most of our readers that some time since, the proprietors of the *Times* newspaper offered a splendid premium for the production of a new raw material which could be employed in paper-making in substitution of rags. What was the result of this offer which is known to have been entirely *bonâ fide*? Simply nothing, but about two years of constant trouble to the appointed referees, leaving the question at issue, just where it was when the premium was offered, and where it remains at the present moment.

USEFUL NOTES AND FORMULÆ FOR ENGINEERS.

(*Continued from page 30.*)

Moments of Strain on a Girder supported at Three Points.

FIG. 13.



Let A B C represent a girder supported at three points, being lettered as before for each span, w' w'' being the loads per lineal foot.

From the equations we find the values of a, M, &c., for each span.

$$M' = \tfrac{1}{4} q l^{2\prime} = o \quad \text{.......... } (a)$$
$$M_1' = \tfrac{1}{4} q_1' l^{2\prime} \quad \text{.......... } (b)$$
$$a = \frac{l'^3\,\theta}{24\,\epsilon} \quad \text{.......... } (c)$$
$$a' = \frac{l'^3\,\theta_1'}{24\,\epsilon} \quad \text{.......... } (d)$$
$$q_1' = w' - \theta \quad \text{.......... } (e)$$
$$\theta_1' = w' - 2\,\theta \quad \text{.......... } (f)$$
$$M' = \tfrac{1}{4} q_1'' l''^2 \quad \text{.......... } (g)$$
$$M'' = \tfrac{1}{4} q''^2 l''^2 = o \quad \text{.......... } (h)$$
$$a' = \frac{l''^3\,\theta_1''}{24\,\epsilon} \quad \text{.......... } (i)$$
$$a'' = \frac{l''^3\,\theta_2''}{24\,\epsilon} \quad \text{.......... } (k)$$
$$q_1'' = w'' - 2\,q_1'' - \theta_1'' = o \quad \text{.......... } (l)$$
$$\theta_2'' = w'' - 3\,q_1'' - 2\theta_1'' \quad \text{.......... } (m)$$

By equations (b) and (g) $q_1'' = q_1' \dfrac{l'^2}{l''^2}$ let us represent $\dfrac{l'}{l''}$ by m, then the above will become $q_1'' = q_1'\,m^2$, and by (d) and (i) $\theta_1'' = \theta_1'\,m^3$; substituting these values in (l) we have

$$o = w'' - 2 q_1'\,m^2 - m^3\,\theta_1'$$

from (e) and (f)

$$\theta_1' = 2 q_1' - w'$$

substituting this in the above equation

$$o = w'' - 2 m^2 q_1' - 2 q_1'\,m^3 + w'\,m^3$$
$$q_1' = \frac{w'' + w^1\,m^3}{2m^2 + 2m^3}$$

If the spans are equal, $m = 1$, and

$$q_1' = \frac{w'' + w'}{4}$$

q_1' being known, we find the moment over the pier from the equation

$$M' = \tfrac{1}{4}\,q_1'\,l'^2$$

Let R_1' R_1'' and R‴ represent the reactions on the piers, then

$$R' = \frac{w'\,l'}{2} - \frac{M'}{l'}$$
$$R'' = w'\,l' + w''\,l'' - (R' + R''')$$
$$R''' = \frac{w''\,l''}{2} - \frac{M'}{l''}$$

The equation to the curve of moments of strain will be

$$\text{for the first span.}\quad M = \frac{w'\,x^2}{2} - \left(\frac{w'\,l'}{2} - \frac{M'}{l'}\right)x$$

$$\text{for the second span.}\quad M = \frac{w''\,x^2}{2} - \left(\frac{w''\,l''}{2} - \frac{M'}{l''}\right)x$$

Moments of Strain on a Girder supported at Four Points.

We will use the same notations with the additional ones q_2''', q_3''', θ_2''', θ_3''', M‴, a''', and w''' for the additional span, and calling $\dfrac{l'''}{l''} = m_2$

The equations for the first span will be,

$$M = \tfrac{1}{4} q l'^2 = o \quad \text{.......... } (a)$$
$$M' = \tfrac{1}{4} q'_1\,l'^2 \quad \text{.......... } (b)$$
$$a = \frac{l'^3\,\theta}{24\,\epsilon} \quad \text{.......... } (c)$$
$$a' = \frac{l'^3\,\theta'_1}{24\,\epsilon} \quad \text{.......... } (d)$$
$$q'_1 = w' - 2\,q - \theta \quad \text{.......... } (e)$$
$$\theta_1' = w' - 3\,q - 2\,\theta \quad \text{.......... } (f)$$

For the second span,

$$M' = \tfrac{1}{4} q''_1\,l''^2 \quad \text{.......... } (g)$$
$$M'' = \tfrac{1}{4} q''_2\,l''^2 \quad \text{.......... } (h)$$
$$a' = \frac{l''^3\,\theta''_1}{24\,\epsilon} \quad \text{.......... } (i)$$
$$a'' = \frac{l''^3\,\theta''_2}{24\,\epsilon} \quad \text{.......... } (k)$$
$$q''_2 = w'' - 2\,q''_1 - \theta''_1 \quad \text{.......... } (l)$$
$$\theta''_2 = w'' - 3\,q''_1 - 2\,\theta''_1 \quad \text{.......... } (m)$$

For the third span,

$$M'' = \tfrac{1}{4} q'''_2\,l'''^2 \quad \text{.......... } (n)$$
$$M''' = \tfrac{1}{4} q'''_3\,l'''^2 \quad \text{.......... } (o)$$
$$a'' = \frac{l'''^3\,\theta'''_2}{24\,\epsilon} \quad \text{.......... } (p)$$
$$a''' = \frac{l'''^3\,\theta'''_3}{24\,\epsilon} \quad \text{.......... } (v)$$
$$q'''_3 = w''' - 2\,q'''_2 - \theta'''_2 = o \quad \text{... } (s)$$
$$\theta'''_3 = w''' - 3\,q'''_2 - 2\,\theta'''_2 \quad \text{...... } (t)$$

From (e) and (f) we obtain $\theta'_1 = 2q'_1 - w'$, from (b) and (g) $q''_1 = m_1^2\,q'_1$; from (d) and (i) $\theta'' = m_1^3\,\theta'_1$; substituting these values in (l) and (m)

$$q''_2 = w'' - 2\,m_1^2\,q'_1 - m_1^3\,\theta'_1 \quad \text{.......... } (n)$$
$$\theta''_2 = w'' - 3\,m_1^2\,q_1' - 2\,m_1^3\,\theta_1' \quad \text{.......... } (n_1)$$

and

$$q'''_3 = w''' - 3\,q''_2\,m^2_2 - 3\,m^3_2\,\theta''_2 \quad \text{.......... } (v)$$
$$\theta'''_3 = w''' - 3\,q''_2\,m_2^2 - 3\,m_2^3\,\theta''_2 \quad \text{.......... } (v_1)$$

From these we obtain,

$$q_1' = \frac{w''' + m_2^2\,(2 + m_3)\,w + m_1^3\,m_2^2\,(2 + 2\,m_2^2)\,w'}{m_1^2\,m_2^2\,[4\,(1 + m_1 + m_1\,m_2) + 3\,m_2^2]}$$

And if the bridge is symmetrical $m_2 = \dfrac{1}{m}$; therefore,

$$q'_1 = \frac{-\,m_1^3\,w''' + (2\,m + 1)\,w'' + 2\,m_1^3\,(m + 1)\,w'}{m_1^2\,(4\,m^2 + 8\,m + 3)}$$

and

$$q''_2 = w'' - 2\,m^2 q_1^1 - m_1^3\,(2\,q_1^1 - w^1)$$

If the spans are all equal, $m_1 = m_2 = 1$, and

$$q_1' = \frac{-\,w''' + 3\,w'' + 4\,w'}{15}$$

and

$$q_2'' = w'' - 4\,q_1' + w'$$

Let R_1' R″ be the reactions produced at each end of the first span, and R‴ the reaction produced on the second support by the centre span,

$$R' = \frac{w'\,l'}{2} - \frac{M'}{l}$$
$$R'' = \frac{w'\,l'}{2} + \frac{M'}{l}$$
$$R''' = \frac{w''\,l''}{2} + \frac{M' - M''}{l''}$$

General equation to curve of moments,

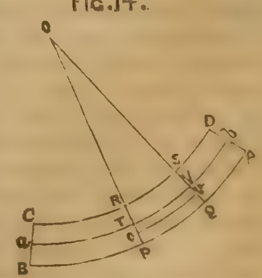
$$M = M' + \frac{w\,x^2}{2}\left(\frac{w\,l}{2} + \frac{M' - M''}{l}\right)x,$$

in which M′ M″, w, and l must be replaced by the letters corresponding to them, in the span for which the curve is to be determined.

Deflection of Beams.

Let A B C D. fig. 14, represent a portion of a deflected beam; $a\,b$ is the neutral axis; R P and S Q are sections taken exceedingly close together at right angles to the neutral axis at T and V; and let O be the centre of curvature of the neutral axis.

FIG. 14.



Let $b\,V = x$, $T\,V = \Delta\,x$, then will $\Delta\,x$ represent the length of each fibre in R S P Q, previous to deflection, since the length of the neutral axis remains unaltered. Let $\delta\,x$ represent the quantity by which the fibre $o\,v$ has been elongated by the deflection of the beam, then the length of it will be $\Delta\,x + \delta\,x$, and the force which must have operated to produce the elongation $\delta\,x$

$$= E\,\frac{\delta\,x}{\Delta\,x}\,\Delta\,k$$

$\Delta\,k$ being the sectional area of the fibre and E the modulus of elasticity.

Let the radius of curvature O T be represented by R, and the distance T o by Z, then by similar triangles

$$\frac{O\,v}{O\,V} = \frac{o\,v}{T\,V}$$

or,

$$\frac{R + Z}{R} = \frac{\Delta x + \delta x}{\Delta x}$$

or,

$$1 + \frac{Z}{R} = 1 + \frac{\delta x}{\Delta x}$$

therefore,

$$\frac{Z}{R} = \frac{\delta x}{\Delta x}$$

Substituting this in the expression for the force which produced the elongation, and calling this force p, we have

$$p = E \frac{\delta x}{\Delta x} \Delta k = \frac{E}{R} Z \Delta k$$

the moment of this force is

$$= \frac{E}{R} Z^2 \Delta k$$

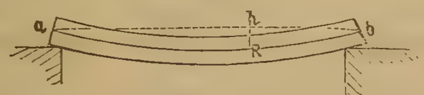
and representing the sum of all the elastic forces by Φ

$$\Phi = \frac{E\,I}{R}$$

where I is the moment of inertia of the section. This gives the moment of the elastic force of any section of the beam in terms of the radius of curvature to that point.

We will now obtain the value of this expression in terms of the curve of deflection.

FIG. 15.



Let $a\,b$ be the neutral axis of the beam as deflected, from its original position $a\,h\,b$, let $a\,h = x$, and the deflection h R $= y$, now we have

$$\text{Radius of curvature} = \frac{d\,x^2 \left(1 + \frac{d\,y^2}{d\,x^2}\right)^{\frac{3}{2}}}{d^2 y}$$

or,

$$\frac{1}{R} = -\frac{d^2 y}{d x^2}\left(1 + \frac{d\,x^2}{d\,y^2}\right)^{-\frac{3}{2}}$$

but as the deflection of beams is usually very small compared with the length of the beam, the inclination to the horizontal of a tangent to the neutral axis is also very small, therefore $\frac{d\,x^2}{d\,y^2}$ may be neglected as compared with unity, whence we may take

$$\frac{1}{R} = \frac{d^2 y}{d\,x^2}$$

substituting in the expression for the elastic forces,

$$\Phi = -\,E\,I\,\frac{d^2 y}{d\,x^2}$$

Deflection of Beams supported at both Ends and loaded at the Centre.

By a former equation

$$M = \frac{W\,x}{2}$$

and as the resistance of the elastic forces is equal to the moment of strain,

$$\Phi = M$$

$$\therefore -\,E\,I\,\frac{d^2 y}{d\,x^2} = \frac{W\,x}{2}$$

calling E I $= e$, and changing the signs,

$$\frac{e\,d^2 y}{d\,x^2} = -\frac{W}{2}\,x.$$

Integrating this we have,

$$\frac{e\,d\,y}{d\,x} = -\frac{W}{4}\,x^2 + \text{constant.}$$

Where $x = \frac{l}{2}$ and the deflection is at a maximum $\frac{d\,x}{d\,y} = o.$

$$\text{constant} = \frac{W}{16}\,l^2$$

$$\therefore \frac{e\,d\,y}{d\,x} = \frac{W}{4}\left(\frac{l^2}{4} - x^2\right)$$

Integrating again,

$$e\,y = \left(\frac{l^2}{4}\,x - \frac{x^3}{3}\right)$$

which is the equation to the curve of deflection, Y being the deflection at a point distant x from the end of the beam.

In applying this equation to various forms of beams, we shall only consider the deflection at the centre of the span, at which it is a maximum. Let D represent the deflection of the beam at the centre, where $x = \frac{l}{2}$ then,

$$e\,D = \frac{W\,l^3}{48}$$

$$D = \frac{W\,l^3}{48\,e}.$$

Maximum Deflection for Rectangular Beams.

a = area, d = depth.

$$D = \frac{W\,l^3}{48\,E\,a\,d^2}$$

For Circular Beams.

a = area, d = diameter.

$$D = \frac{W\,l^3}{3\,E\,a\,d^3}$$

For any other form the deflection may be obtained by substituting E multiplied by the moment of inertia for the section.

Deflection of Beams supported at both Ends and loaded uniformly

In this case

$$M = \frac{w}{2}\,(l\,x - x^2)$$

$$\therefore \frac{e\,d\,y^2}{d\,x^2} = -\frac{w}{2}\,(l\,x - x^2)$$

Integrating this,

$$\frac{e\,d\,y}{d\,x} = -\frac{w}{2}\left(\frac{l\,x^2}{2} - \frac{x^3}{3}\right) + \text{constant.}$$

and the constant,

$$= \frac{l^3}{12} \times \frac{w}{2}$$

$$\therefore \frac{e\,d\,y}{d\,x} = \frac{w}{2}\left(\frac{l\,x^2}{2} - \frac{x^3}{3} - \frac{l^3}{12}\right)$$

and integrating again,

$$e\,y = \frac{w}{24}\left(x^4 - 2\,l\,x^3 + l^3\,x\right)$$

which is the equation to the deflection curve.

Making D = deflection at centre,

$$e\,D = \frac{5\,w\,l^4}{382}$$

$$D = \frac{5\,w\,l^4}{384\,e}$$

Maximum Deflection of Rectangular Beams.

a = area, d = depth.

$$D = \frac{5\,w\,l^4}{32\,E\,a\,d^2}$$

For Circular Beams.

a = area, d = diameter.

$$D = \frac{5\,w\,l^4}{24\,E\,a\,d^2}$$

Practical Formulæ.

To find the Modulus of Elasticity.

This may be found by measuring the elongation of a bar under a strain which does not produce a permanent set, and calculating the modulus from the data thus obtained. Another method, which is, perhaps, more accurate, is to calculate the modulus of elasticity from the deflection of a beam; the moments of inertia, moments of strain, and deflection being known, we can easily find a formula for the modulus. Thus, if the load be applied at the centre, we have

$$D = \frac{W l^3}{48 e}$$

but $e = E \times I$, therefore,

$$E = \frac{W l^2}{48 D I}$$

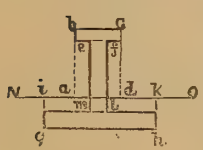
Neutral Axis.

A practical means of finding the position of the neutral axis has lately been proposed, which has certainly the advantages of simplicity.

On good homogenous paper draw, to any scale, the section of which the neutral axis is required; find experimentally on what point the paper section will remain in equilibrium when carefully cut into form:—the neutral axis will pass through that point.

Moments of Inertia.

FIG. 16.



Some formulæ for symmetrical sections are given already; but for sections not symmetrical we must proceed in a different manner.

Let the moment of inertia be required for such a section as is shown in Fig. 16. The neutral axis N o having been found, the moment of the part of the section above the neutral axis is determined by the formula,

$$I = \frac{b d^3 - b_1 d_1^3}{3}, \text{ where}$$

$$b = b\,c,\ b_1 = b\,c - e\,f,\ d = b\,a,\ d_1 = e\,a$$

and the moment of the lower part, found in a similar manner, is added to the moment of the upper part to find that of the whole section. If there are any lateral appendages to the section, their moment of inertia about the neutral axis may be found separately, and added to that of the part of the section to which they belong. We will here give an example of the application of the above formulæ to the strength of beams.

The fibre which is most strained is that which is furthest from the neutral axis, and we must consider the greatest strain per sectional inch, which is allowed as the resistance which this fibre offers. It is required to find the greatest safe load which a beam 6in. deep, 3in. wide, and 8ft. long will bear, the greatest safe strain being taken at 5 tons per square inch.

Then we have 5 tons resistance per square inch from the top fibres of the beam.

$$\Phi = \frac{s}{h} I$$

Φ = moments of resistance.
I = moments of inertia.
h = distance of given fibre from neutral axis = 3 inches.
s = strain on given fibre = 5 tons per square inch.

If b = breadth, and d = depth of beam,

$$I = \frac{b d^3}{12} = 54$$

$$\frac{s}{h} = \frac{5}{3} = 1{\cdot}666$$

$$\therefore \Phi = 90$$

but the moments of the of strain are equal to the moments of resistance, or

$$M = \Phi$$

If the load W is applied at the centre of the girder

$$M = \frac{W l}{4}, \text{ is the maximum strain, } l \text{ being the length,}$$

$$l = 8\text{ft.} = 96\text{in.}$$

$$\frac{W\,96}{4} = 90 \text{ tons.}$$

$$W = 3{\cdot}75 \text{ tons.}$$

We will now apply the geometrical method. The base of each triangle is 5, the height is 3; therefore the area of the two triangles $= 5 \times 3 = 15$. Multiply this by the distance of the centre of gravity of one triangle from the neutral axis, $15 \times 2 = 30$, and by the breadth of the beam in inches $30 \times 3 = 90$,

$$\therefore \Phi = 90.$$

which agrees with the result of the algebraical formula.

Formulæ for the Strength and Deflection of Beams.

W = weight at the centre.
D = deflection.
w = weight per inch lineal.
l = length of beam.
E = modulus of elasticity.
I = moments of inertia.
s = the greatest strain per inch allowed.
h = distance of most remote fibre from neutral axis.
All dimensions in the same name.

Beams supported at one End and loaded at the other.

(W is in this case placed at the end of the girder.)

$$W = \frac{s I}{h l}$$

$$D = \frac{W l^3}{3 E I}$$

Beams supported at one End and loaded uniformly.

$$W = \frac{2 s I}{h l}$$

$$D = \frac{5 W l^3}{24 E I}$$

Beams supported at both Ends and loaded at the Centre.

$$W = \frac{4 s I}{h l}$$

$$D = \frac{W l^3}{48 E I}$$

Beams supported at both Ends and loaded uniformly.

$$W = \frac{8 s I}{h l}$$

$$D = \frac{5 W l^3}{384}$$

The strength of continuous beams may be found by equating the moments of resistance of their sections with the moments of strain (for which the formulæ are given above), and finding the value of W.

(To be continued.)

IMRAY, PIGNA, AND DATICHY'S APPARATUS FOR EFFECTING ECONOMY IN THE GENERATION AND USING OF STEAM.

For several months past the high pressure steam engine employed upon the premises of Messrs. Collinge and Co., the engineers in the Westminster-Road, has had applied to it a surface condenser and its connections; and an improved feed-water heating apparatus has been inserted behind the bridge of the boiler, through which vessel the distilled water resulting from the condensation of the steam is forced and caused to circulate before entering the boiler.

On the 8th Feb. an experiment was tried at Messrs. Collinge's in the Westminster Bridge-road, to practically test the results of the working of this apparatus, a number of engineers and others having been invited.

Want of space prevents us from giving a detailed description and woodcut of the apparatus, which must therefore be deferred. We may, however, state, that from diagrams taken from one end of the cylinder, with the apparatus in use, and also without the patented apparatus, as well as from other reliable results obtained, the economy incident to the use of the invention is clearly established.

The apparatus has been in use at the following works in Paris, where we understand it has given entire satisfaction, also effecting considerable economy:—At the Malleable Iron Foundry, 306, Quai Jemmapes; Optical Instrument Works, 18, Rue Meuilmontant; Wire Factory, 16, Rue des Vinaigriers; Works of Beudon, 19, Route de Choisy; M. Thiebault's Brass Foundry, 144, Rue de Faubourg St. Denis.

Sig. Pigna and Capt. Fernandez have now in their hands the whole of the patents obtained throughout Europe and America, and we are informed that they intend to supply the apparatus to the owners of steam power, free of cost, taking in payment for the apparatus and royalty the savings in coal alone, which may be effected by the introduction of the apparatus.

IMPROVEMENT IN CARDING MACHINERY.

We have had brought under our notice a practically useful and valuable Improvement in Carding Machinery, introduced by Mr. Joseph Cedric Rivett, of Prestolee new Mill, Farnworth, near Manchester, and which invention has been secured by Letters Patent.

The advantages stated to be possessed by the improved carding engine of Mr. Rivett, over the carding engines in general use, are so great that we consider we cannot do better than lay before our readers a brief summary of the merits of Mr. Rivett's invention.

1st. We are informed Mr. Rivett's carding engine will produce from 30 to 40 per cent. more work (and that superior in quality) than could be carded on an ordinary engine of the same size.

2nd. It is not dependant on the attention of the operative for stripping or cleaning; this process being entirely automatic.

3rd. The waste made is not more than half of what an ordinary engine makes, although doing 30 to 40 per cent. less work.

4th. In the usual carding engines the stripping of rollers is done by hand at stated intervals. Consequently, after being stopped and stripped the sliver is delivered much thinner or lighter than it was previous to stripping. An irregularity is the consequence, which no subsequent process can entirely correct, resulting in a considerable variation when the sliver has been drawn or attenuated into a thread. It is also evident that between one round of stripping and the next, the rollers are gradually charged with dirt, motes, and short fibres; when so charged some must of necessity be carried forward and intermixed with the cleaned cotton. In the improved engine the stripping is performed automatically, and never varies; every moment the rollers present points of clean wire, to the wire on the periphery of the cylinder, thus insuring perfect regularity, evenness of sliver, and without motes or dirt.

5th. The wire cards—an expensive item—are by hand-stripping liable to damage. By the new plan of stripping this is obviated; the wire retains its edge or point for a much longer period, there is considerable less wear, and a great saving in grinders' wages.

6th. In the alterations the clearers are dispensed with. These, in ordinary engines, require to be driven at great velocities, causing much waste, a large amount of care and attention; they are a source of mischief, requiring very frequent lubrication and considerable motive power. The only quick motions in the new engine are the taker-in, cylinder, and crank.

Stripping by hand is a very unhealthy occupation, because the operatives when in close contract with cylinder and roller cannot help inhaling the short fibres of cotton, dust, dirt, &c. On this ground alone, to say nothing of the increased and superior production, as well as saving waste, wages, &c., we venture to think the self-acting stripper a decided improvement.

The arrangements may be applied to any carding engines of usual construction without any material cost, considering the advantages to be derived from the introduction of the improvement.

It is probable a carding engine of the new construction will be exhibited at the International Exhibition of 1862.

We ought to remark that the finest and longest stapled, as well as the shortest or East India qualities, may be carded with equal results, and that practical men say that it is superior for fine numbers to any "flat" engine, *i.e.*, engines with "flats" extant. "Flats" have heretofore been neccessary for fine counts; say 68's to 200's.

THE LIFE BOAT AND HER WORK.

(*Illustrated by Plate* 207.)

While the battle field on the American plains is yet red with blood, and the wail of widows and orphans is ringing in their country's ears, and while the havoc of war is still visible there in desolated fields and dismantled hamlets, it may be some consolation to the friends of humanity on this side of the Atlantic to know that there are special arts of peace, and special applications of science, by which human life is saved, and property, individual and national, rescued from destruction. To the philanthropist who looks upon war but in its social aspect, and as an institution under which the lives of the brave are wantonly and wickedly sacrificed, the amount of life which science has rescued from destruction may appear a trivial source of gratification, and merely a fractional offset against the countless victims of war; but it is in its moral phase that the Christian patriot must make the comparison. We cannot highly estimate the value of that life of which the owner is prodigal,—which he voluntarily hazards for lucre or for fame, or which he squanders on the forlorn hope, or throws away in the personal encounter. The hero is a martyr by choice—a victim self-laid upon the altar of ambition; and to bewail his fate is to make light of his calling, and question the whole aim and end of his being. His profession is to slay and be slain, and when he falls—"he falls in the blaze of his fame."

How different is the fate of those who in mid-ocean are overtaken by the thunderbolt or the tornado, or who, within sight of their native shore, are dashed upon the wild shelves by which it is defended. The merchant returning to his home—the traveller to his country—the emigrant to his friends—the soldier to his family—and the mariner to his haven, all instinct with life and hope, become the sudden victims of these disasters at sea which science alone can counteract or alleviate. Escaping from the fatal cyclones of the tropical seas, and unscathed by the lightning bolt that has rushed through its masts into the deep, the joyous vessel approaches its destination at midnight, anticipating the greetings of a happy morning. A cloud spot in the azure vault reveals an element of danger. The stars disappear in the rising haze; the beacon lights shine feebly or falsely; the gentle breeze freshens into a gale, and amid the discord of rending canvas, of creaking timbers, and clanking chains and raging waves, the startled passenger rushes from his couch to witness his ship in the arms of breakers,—to welcome the life boat that has been sent to save him, or to bid God-speed to the rope of mercy that is to connect him with the shore.

Such a scene as this is not of unfrequent occurrence on the Goodwin sands, where some of the noblest life-boat services are from time to time performed. On the occasion to which our illustration refers, the lifeboat had put off in a heavy gale of wind, and succeeded, after repeated endeavours and at much risk of life, in rescuing thirteen Portuguese sailors and five Broadstairs boatmen, who had gone to their assistance, from a Portuguese brig, which was totally wrecked on the Goodwin Sands. Never before or since, did men and life-boat live through such perils. The crew consisted of hardy daring fellows, ready to face any danger, to go out in any storm, and to do battle with the wildest seas; but that night was almost too much for the most iron nerves. The fierce, freezing wind, the darkness, the terrible surf and beating waves, and the men unable to do anything for their safety; the boat almost hurled by the force of the waves from sandridge to sandridge, and apparently breaking up beneath them each time she was lifted on the surf and crushed down again upon the sand, besides the danger of her getting foul of any old wrecks, when she would have gone to peices at once—how all this was lived through seems miraculous. Time after time there was a cry, "Now she breaks—she can't stand this—all over at last—another such a thump and she's done for!" and all this lasted for more than two hours, as almost yard by yard for about two miles they beat over the sands. At last they got over them into deep water, the danger was past, and they were saved.

As we consider the self-righting life-boat of the National Life Boat Institution is one of the greatest triumphs of modern science on behalf of suffering humanity, we have always felt a pleasure in recording its success. We therefore now proceed to make a few remarks on the lifeboat and her work, as every fact connected with it cannot fail, we feel persuaded, to be interesting to the readers of the *Artizan*.

The dangers of the deep have an interest for Britons which touches their liveliest sympathies in a manner equalled by no other subject whatever—not only because our greatest glories have been won upon the sea, but because there is something in the blood of a Briton which is in sympathy with its freedom, and feels at home in braving its perils. It has carried him to the utmost regions of the earth, where he has founded new empires. It is the pathway of his commerce, and the field on which his national glory has long survived that of the old Republics of Italy and the merchant fleets of Portugal. On its heaving plains he has for nine centuries been masterly sweeping before him the fleets of France, of Spain, of Denmark, and of Prussia. All this has grown out of our national instinct or inborn love of the ocean; that instinct that makes a boat the cherished toy of boyhood, the pastime of stronger youth, and a ship the admiration of manhood. The adventures which most fire British emulation, and the disasters which awaken its deeper interest are those which occur on the sea. The story of a shipwreck has a fascination for a Briton far exceeding the most moving accident by land. The success of a cutting-out expedition of boats' crews excites his admiration more than the most brilliant sally of a garrison; but, above all, the lifeboat on her errand of mercy rouses the noblest emotions of his heart. Here no ordinary passion is at work; neither the love of gain, nor the principle of self defence, nor the instinct of nationality which urges the soldier to the work of slaughter. Life is imperilled to save life, and here, again, the national character shines out wherever there is need.

With the voice of the storm at the present period, be it ever so low or ever so distant in its tones, comes the memory of those who go down to the sea in white-winged ships. Conjectures as to the fortunes of their hazardous existence arise unbidden within our souls. The sailor-boy rocked on the topmost height of the giddy mast—the hardy watcher who keeps his vigil on the sea-washed deck—the stout-armed helmsman who guides the staunch and gallant barque across the billows of the yawning deep, are all agents for our comfort, ministers to our wealth, or promoters of our commerce. Without the aid of their special services, much of the advantages of art and skill would be lost to our enjoyment or our necessities. The spread of science or religion or civilization would be slow and inefficient, and the human race would remain deprived of much of its resources and be poor in opportunity for progress. Yet this class of workers in the labour of the world have probably the least share of the advantages that result from their toil. The terms of their ordinary existence are far from being attractive or fascinating, and the danger to which it is subject is beyond all calculation. Human life is hazardous—very hazardous; indeed, in the best and strongest amongst us a chance blow or a chance slip may cut it short almost without warning; but for all those whose home is on the sea, a plank is all that intervenes between them and certain death. If that be frail, if a nail start, or a worm gnaw through it, the rushing waters will do the rest. The brave vessel will settle down with its living freight "deeper than did plummet ever sound." Yet these are probable, but not very frequent dangers of the seaman's life. It is on the iron rocks along our coasts that the most woeful sacrifices of life take place. Among them the stoutest ship that ever outrode a storm in mid-ocean may meet her perilous fate, and the hardiest and most skilful seamen may find their graves within sight of land. To the struggling mariner in the grasp of the wild waves there is very frequently but one chance for human succour, and that is afforded oftenest by the gallant crew who man the lifeboat. Many a time when the pitiful cry of human hearts is wafted on the wings of the storm from the shrouds or deck of the perishing vessel in the gripe of the whirlwind, there are listening ears and gallant men on shore who echo it back with a cheery and hopeful response; as, dashing with their boat to the beach, they launch it amid the raging surf, and venture to the rescue. How often have they restored its dearest one to home when, the raging sea would have doomed the hope and trust of a household! How often has a family had cause to bless the courageous souls who have ventured in the very teeth of death to save the victim who was almost taken for ever from their embrace! and how often has the passionate sob of some despairing derelict wretch broken into a prayer of gratitude to heaven as, sweeping buoyantly over the seething waves, he has beheld careering amid the spray the little barque that brought him life renewed?

According to the official register of shipwrecks on the coast and in the seas of the United Kingdom, a synopsis of which has just been published by the National Lifeboat Institution, the average annual loss of 800 lives takes place, and property to the amount of one million and a half is devoted to destruction in the seas and on the coasts of the United Kingdom. During the year 1860 there was by shipwrecks a total loss of 1,379 vessels; in other words an increase in the gross number of casualties of 146 beyond the average of the past six years. Accidents from collisions have however decreased in a great degree owing to the improved measures taken for prevention of wreck from such causes, 298 collisions only having taken place in 1860, against 349 in 1859. The total loss of life from all the casualties at sea during the year 1860 was 536, being 264 less than the average of the past nine years, a gratifying fact, which must be mainly attributable to the lifeboat, for 2,152 persons were saved from death. The rocket and mortar apparatus were found most serviceable, and even shore-boats were made available in this noble and philanthropic work. The vessels wrecked would seem to have been much influenced by class, as during two years out of 2,795 ships lost on our coast, more than half (1504) were colliers and of that class; and 1291 were timber-laden, passenger ships, and vessels in ballast. In tonnage it is found that ships between fifty and three hundred tons are those to which casualties most frequently occur. In rig, schooners figure as by far the heaviest in the melancholy category, 912 of them having gone to pieces, and next to these the brigs have suffered most, 644 of them having been lost. A very important fact bearing on the efficiency of commanders of vessels, is that out of the 1379 ships wrecked in 1860, 554 were commanded by masters who were not required to have certificates of competency. Twenty-one wrecks took place from not taking soundings, thirty-five from general negligence, thirty-nine from unsea worthiness, five from defective compasses, and two from intemperance. Perhaps one of the most extraordinary of the details revealed by these very interesting statistics is that eight ships were wrecked during calm weather. Such a statement is one for which the general public can hardly be prepared, and is a curious instance of the uncertainty of a sailor's life. During the last eleven years, the points between Skerries, Lambay, and Carnsore Point, and St. David's Head on one side, and Skerries, Lambay, Fair Head, and the Mull of Cantyre on the other, are those upon which the loss of life has been by far the greatest, being 2332 out of 6883, or above a third of the whole.

These are very interesting statistics, they reveal an appalling loss of life, but they are not without valuable evidence of its gain also. During the past five years the number of lives saved on the coast by lifeboats, lifesaving apparatus, and other means has been 11,495. These numbers are a noble testimony to the value of the exertions which have been made in a good and holy work. In the cause of humanity danger has been met with a calm heroic courage, better, as it is higher, than warrior ever knew in the intoxication of battle. The storm might rise, the sea might swell with appalling power, and the night be dark with horror, but despite of wind and waves, and darkness, the lifeboat has sped on its mission of mercy with wonderful success. Reading over the records—touching and affecting—of its fortunes on these brave occasions, we are anxious that the National Lifeboat Institution, which has given rise to so much good to our species, should receive that encouragement and support of which it is so deserving throughout the British isles, where we know hearty sympathies exist for the continued services of its merciful operations in the cause of suffering humanity. When we read of the Seaton Carew lifeboat taking off the crew of the brig *Providence*, wrecked off Hartlepool, and landing them in safety, and then braving the storm again to take off the crew of the *Mayflower*, and when we find that the cost of those great and philanthropic deeds is only £25 for the sixteen lives saved, we cannot but regard it as money laid out at a valuable interest. At Portmadoc seventeen men were saved at a cost of £14. At Carnsore nineteen persons were saved at an expense of £22 14s. by the same means. Could there be a greater return than this for money? Can wealth purchase so great an enjoyment as the blessings of a child rescued from impending orphanage—a wife saved from the poverty and sorrow of widowhood, a mother spared the prop of her old age; or can there be any reward so estimable as the reward that comes of the prayers and blessings of these. In the purposes of the National Lifeboat Institution such fruits come of so trivial a sum. In the wild time of storms, day or night, its agencies are at work to save and to succour.

During the last two years the lifeboats of the Institution have been the means of rescuing 498 lives from the following shipwrecks on our coasts:

Schooner *Ann Mitchell*, of Montrose...	1
Schooner *Jane Roper*, of Ulverstone ...	6
Brig *Pallas*, of Shields	3
Ship *Ann Mitchell*, of Glasgow........	9
Smack *John Bull*, of Yarmouth	5
Schooner *Catherine*, of Newry	4
Barque *Niagara*, of Shields	11
A Barge of Teignmouth	2
Brig *George and James*, of London......	8
Brig *Zephyr*, of Whitby	6
Coble *Honour*, of Cullercoats........	3
Schooner *Eliza*, of North Shields........	7
Barque *Oberon*, of Liverpool..	15
Brigantine *Nancy*, of Teignmouth	9
Smack *Wonder*, of Teignmouth	2
Brig *Scotia*, of Sunderland........	6
Sloop *Three Brothers*, of Goole........	5
Sloop *Charlotte*, of Woodbridge	5
Brig *Ann*, of Blyth	8
Sloop *Hope*, of Dublin........	3
Schooner *Druid*, of Aberystwith........	5
Barque *Vermont*, of Halifax, U.S........	16
Schooner *William Keith*, of Carnarvon	2
Brig *Flying Fish*, of Whitby........	5
Smack *Elizabeth Ann*, of Lyme Regis...	3
Steam Dredge, at Newhaven........	9
Schooner *Admiral Hood*, of Rochester	6
Schooner *Susan and Isabella*, of Dundee	5
Schooner *Rose*, of Lynn........	3
Brig *Prodroma*, of Stockton	11
Brig *Eliza*, of Middlesborough........	7
Brigantine *Freia*, of Konigsberg........	6
Brigantine *Diana*, of Fredriksham......	7
Brig *Gloucester*, of South Shields........	7
Brig *Lovely Nelly*, of Seaham	6
Brigantine *Nugget*, of Bideford........	5
Schooner *Prospect*, of Berwick........	6
Sloop *Thomas and Jane*, of St. Ives......	3
A Fishing-boat of Whitburn........	4
Brig *Arethusa*, of Blyth	8
Schooner *Dewi Wyn*, of Portmadoc......	8
Flat *Cymraes*, of Beaumaris	2
Schooner *William*, of Morecambe	5
Smack *Gipsy*, of Newry	4
Schooner *Margaret Anne*, of Preston...	4
Brig *New Draper*, of Whitehaven	8
Schooner *William*, of Liverpool	5
Lugger *Nimrod*, of Castletown........	3
Brig *Providence*, of Shields	8
Brig *Mayflower*, of Newcastle	8
Schooner *Village Maid*, of Fleetwood ..	4
Barque *Guyana*, of Glasgow........	19
Brig *Roman Empress*, of Shields	10
Brig *San Spiridione*, of Galaxide........	2
Schooner *Voador du Vouga*, of Vianna	8
French Brig *La Jeune Marie Therese*..	6
Barque *Perseverance*, of Scarborough...	5
Schooner *Elizabeth*, of Bridgewater	4
Ship *Danube*, of Belfast	17
Schooner *Hortensia*, of Hanover	4
Schooner *Oregon*, of Stonehaven........	4
Brig *St. Michael*, of Marans	8
Spanish Barque *Primera de Torreviega* —Saved vessel and one of the crew...	1
Schooner *Hurrell*, of Penzance—Saved vessel and crew........	4
Brig *Anne*, of Plymouth—Saved vessel and crew	8
Schooner *Betsey*, of Peterhead—Saved vessel and crew	6
Barque *Frederick*, of Dublin	1
Schooner *Fly*, of Whitby—Saved vessel and crew	4
Smack *Adventure*, of Harwich........	10
Pilot cutter, *Whim*, of Lowestoft........	7
Barque *Undaunted*, of Aberdeen	11
Wrecked boat on Blackwater Bank, on the Irish Coast	1
Schooner *Skylark*, of Folkestone........	6
Brig *Lively*, ot Clay, Norfolk	5
Barque *Robert Watson*, of Sunderland	5
Schooner *Auchincruive*, of Grangemouth	6
Schooner *Friends*, of Lynn	4
Schooner *Eliza Anne*, of Dublin	5
Barge *Peace*, of London........	2
Lugger *Saucy Lass*, of Lowestoft........	11
Brig *Content*, of Sunderland	5
Smack *Ellen Owens*, of Cardigan........	3
Galliot *Epimachus*, of Amsterdam	[illegible]
Total........	498

Such noble services performed by the lifeboats within so short a period as the above list represents, reflects honour on the philanthrophy of the age we live in, in addition to the important services thus rendered to our commerce, even to the protection of our shores, for 498 persons would man a large line-of-battle ship.

Secure in our homes when night is pleasant by the warm ingle nook, we and ours may rest while brave ships drive headlong on the rocks and strand by many a lone headland; but let us not be forgetful of the strong man who may struggle in despair with the fierce elements, or of the trembling ship boy crying for help. Let us on the contrary borrow peace for ourselves amid the perils of the storm, which wakes us up in the night by the consoling thought that each of us has in his own humble way, and out of his own means given something to man a lifeboat of the National Lifeboat Institution.

ROLLER SKIDS.

(*Illustrated by Plate* 206.)

There are doubtless few persons that reside on, or have visited, our coasts who have not frequently watched with interest the picturesque groups of fishermen and other boatmen hauling up their boats, and observed the contrivances by which that often laborious operation is made more easy of accomplishment—varying according to the size of the boat, the character of the beach, or mere local custom.

At one place, as at Deal or Hastings, with their steep shingle beaches, large boats, and numerous bodies of boatmen, will be seen, the long row of powerful capstans, by the aid of which the large decked or half-decked smack, or hovelling boat, or trawler, is hauled up with comparative ease, yet seemingly reluctant to leave her native element, in which her weight is nothing, and in which she lives and moves; to hibernate, as it were, for a time with suspended life and animation, motionless on the land. There, also, it will have been observed that long flat boards of hard wood, with their upper surface greased, are placed under the boats when hauling up or launching, so as to reduce as much as possible the friction as they are dragged along.

At another place, as at Great Yarmouth or Lowestoft, with a flatter and sandy shore, their long and graceful yawls and smaller craft are, for the most part, hauled up by hand alone, the numerous boatmen being banded together in companies and mutually assisting each other in the operation. Here the friction of hauling up is lessened by employing small portable machines consisting of a strong wooden frame with two or three iron rollers fixed in it, which is traversed by the boat's keel, she being held in an upright position by men at her sides.

Again, farther north, on the still flatter sands of Northumberland, Durham, and Yorkshire, where the three-keeled and graceful coble abounds, the fishermen, often aided by their wives and daughters, will be seen lifting them on the little wooden trucks, on which they are wheeled along on the hard and level strand.

As the hauling up of a heavy boat is a laborious work, which men who have been many hours, perhaps all night, in their boats, would be very glad to dispense with, and since, as implied above, their mode of performing it is sometimes rather the result of custom than of scientific appliance, we think that we may usefully circulate, for the information of boatmen to whom they are at present unknown, drawings of the "roller skids" used by the Norfolk and Suffolk boatmen in hauling up their larger boats, and which have been adopted by the National Life Boat Institution, and found valuable auxiliaries in hauling up its life-boats, saving much labour, trouble, and expense.

There are three varieties of these skids used by the life-boats of the Institution—one is the simple wooden frame with either two or three rollers in it (Fig. 1), which is sufficient on hard ground, moveable short boards being placed under it transversely where the beach is soft. A second (Fig. 2) is similar, but having its sleepers attached to it beneath the rollers, which form is more convenient for placing under a boat whilst she is still in the water. Much labour is saved by hauling a heavy boat on the rollers whilst she is still partly water-borne, and it is awkward to place a detached board under a skid under water, especially when the boat has much motion from the surf. A skid of this description can, by means of two short lines attached to it, as shown in the figure, be readily hauled under the stem or sternpost of a boat by two men or lads, one dragging by each line. These lines should be of Manilla rope, which will float and thus indicate the position of the skid when under water. Two inch rope will be found a convenient size.

A third variety (Fig. 3) is a shorter skid, similar to the above, fitted to turn on a pivot-bolt fixed in a flat piece of wood, thus forming a portable turn-table, on which a boat, when hauled over it, can be turned round with very small power in any direction. The life-boats of the Institution are supplied with one of these turn-tables, with two of the second variety, or water skids, for use in the water, and with two of the plain skids with detached sleepers. A less number would, however, be sufficient for ordinary use, unless for very large and heavy boats; and we strongly recommend them to the attention of the boatmen on those parts of the coast where they are not already in use, as they have been of great service in moving the life-boats of the National Life-boat Institution.

BAROMETER INDICATIONS.

(*Illustrated by plate* 206.)

At a late meeting of the Meteorological Society, Thomas Sopwith, Esq., F.R.S., who had recently come from Northumberland, stated that from information he had received, there was grounds for supposing that a large number of lives had been saved by the caution which had been induced by attention to the barometers on that coast. Captain Washington, R.N., F.R.S., who had also recently visited the coast of Northumberland, in a letter to the National Life Boat Institution, bears evidence to the interest taken in the barometer by fishermen, and to their watching the records of its movements, day by day, as shown in charts, like the annexed, which has been laid down from observations taken daily at the Life Boat Institution from one of Negretti and Zambra's Barometers, during the month of November, 1861. In addition to the instruments on the coast of Northumberland, the National Life Boat Institution has placed no fewer than from 40 to 50, of like character, all examined by myself, at as many different places round the coast, at everyone of which places a chart laid down like the above is exposed to view. It is impossible to say how many lives may have been saved by the daily inspection of the zig-zag line caused by the varying pressure of the atmosphere, in conjunction with the local knowledge of the climate of each locality possessed by every fisherman, causing caution on the one hand by the day-by-day falling of the line, and certainty on the other, by the day-by-day rising of the line on the chart. The chart at once speaks to the eye, the past variations of the pressure of the atmosphere being seen at a glance, for instance, by reference to the diagram it will be seen that at the beginning of the month the barometer reading was low, being 29·22in. on the first day, and decreased to 29·18in. by the 2nd. It then turned to increase, and on the 4th was 29·95in.; decreased to 29·50in. by the next day, and to 29·27in. by the 8th; increased to 29·73in. by the 12th; then fell rapidly to 29·18in. by the night of the 13th; but this point, the lowest in the month, is not shown on the chart in consequence of its occurring at night. It then increased to 29·27in. by the 14th, then increased, rapidly passing the point, 30in., on the 17th, to 30·56in. by the 19th, or nearly one inch and a half in six days, this being the highest reading in the month. A fall as rapid then set in, and the reading passed below 30in. on the 21st to 29·39in. by the 23rd, and from this time to the end of the month the readings were alternately increasing and decreasing, but generally low.

The pressure of the atmosphere, until the 16th, with the exception of the 4th, was always below the average, from the 17th to the 20th, 24th, 25th, and the 28th, above, and the remaining days below. The average for the month at the level of the sea was 29·74in., being two-tenths of an inch in defect of the average of the month, and when compared with the preceeding 20 years, one instance alone of less pressure, viz., in 1852, and one of equal pressure in 1845, are fonnd. In all other Novembers, eighteen in number, the pressure of the atmosphere has been greater than in the past month.

The fall of rain in the month was no less than 5¼in., exceeding the average for the month by 2⅞in. In November, 1852, 6in. of rain fell, with this exception the fall of rain was greater in the past month than in any November in the preceeding 45 years. Snow fell on the second day.

Satisfactory as it is to know that so many charts of weather are constantly on view, where so much needed, yet we cannot avoid fearing that loss of life may result on other equally exposed coasts for the want of similar instruments, for certain it is that the number of barometers require to be greatly increased.

It will probably be remembered that fearful storms swept the north east coast of England on the 2nd, 3rd, and 14th ult., when the lowest points marked on the accompanying chart were reached. On these occasions great loss of life as well a destruction of property took place. It is however gratifying to find that valuable services were rendered by the lifeboats of the National Life Boat Institution in saving the crews of the following wrecked vessels:—Smack *Adventure*, of Harwich, 10; lugger *Saucy Lass*, of Lowestoft, 11; schooner *Fly*, of Whitby, saved vessel and crew of four hands; pilot cutter *Whim*, of Lowestoft, 7; barque *Undaunted*, of Aberdeen, 11; brig *Lively*, of Clay, Norfolk, 5; barque *Robert Watson*, of Sunderland, 5; schooner *Auchincruive*, of Grangemouth, 6; and schooner *Friends*, of Lynn, 4. Total 63. Making an aggregate total of two hundred and eighty-eight persons rescued from a watery grave by the lifeboats of the Institution during the psat year alone.

JAMES GLAISHER.

Royal Observatory, Greenwich, Dec. 14, 1861.

STRENGTH OF MATERIALS

DEDUCED FROM THE LATEST EXPERIMENTS OF BARLOW, BUCHANAN FAIRBAIRN, HODGKINSON, STEPHENSON, MAJOR WADE, U.S. ORDNANCE CORPS, AND OTHERS.

By Charles H. Haswell, C.E.

(*Continued from page* 32)

Deflection of Bars, Beams, Girders, &c.

From the experiments of Barlow on the deflection of wood battens, he deduced that the deflection of a beam from a tranverse strain, varied as the breadth directly and as the cubes of both the depth and length, and that with like beams and within the limits of elasticity it was directly as the weight.

These deductions are supported by the particular experiments referred to, and although they have been subsequently supported by the experiments of Hodgkinson on cast iron bars, having like conditions of proportionate section to length, an extended examination of the subject, aided by further elements, will show that, however correctly these laws may apply in the cases referred to, they are inapplicable in varied conditions of section, length, and material.

If the lines of deflection of bars, beams, &c., were right lines, meeting at the point of bearing of the stress, or in other words, in the neutral axis of the section at that point, the deflection would be directly as the resistance of the bar, beam, &c., to transverse stress, inasmuch as the point of rupture of the fibres, or of the material of the bar, &c., would depend upon the angle of the bar, at the point of the application of the stress, and the measure of the angle, being the versed sine of it, would be the same, without reference to the lenth of the bar, as in like angles, the versed sines are directly as the length of their bases. Thus, if the deflection of a bar, 10 feet in length between its supports, was 5·25 inches, the angle of deflection from a horizontal plane would be five degrees: *hence,* the angle of deflection at any other length would be the same, and, consequently, the resistance of a bar, &c., to deflection alike to that of tranverse strain, would be directly as its length. It occurs, however, that the line of deflection is that of a curve; *hence,* although the angle of rupture, measured from the neutral axis of the section of the bar, &c., would be the same, yet this angle, in consequence of the curvature of the plane of the bar, &c., will be depressed in proportion to the curvature, and whilst it remains the same, the deflection or versed sine of the angle of the neutral axis of the section and the plane of the bar, &c., at the points of support, will be increased proportionate to the versed sine of the arc of curvature.

Therefore, in bars, beams, &c., of an elastic material, and having great length compared to their depth, the deductions of Barlow will apply with sufficient accuracy for all practical purposes; but in consequence of the varied proportions of depth to length, of the varied character of materials, of the irregular resistance of beams constructed with scarfs, trusses, or rivetted plates, and of the unequal deflection at initial and ultimate strains, it is impracticable to give any positive laws regarding the degrees of deflection of different and dissimilar bars, beams, &c.

In the experiments of Hodgkinson, it was further shown that the sets from deflections were very nearly as the squares of the deflections.

In a rectangular bar or beam, the position of the neutral axis is in its centre, and it is not sensibly altered by variations in the amount of strain applied. In bars or beams of cast and wrought iron, the position of the neutral axis varies in the same beam, and is only fixed whilst the elasticity of the beam is perfect. When a bar or beam is bent so as to injure the elasticity of it, the neutral line changes and continues to change during the loading of the beam until it breaks. When a beam is supported at the ends and loaded in its middle with different small weights, they are reciprocally proportional to the radius of curvature at that point, and the curvature itself is consequently proportional to the weight.

When a Bar or Beam is fixed at one End and loaded at the other, the fundamental property of the curve of deflection is, that the curvature at every point is as the distance of that point from the line of direction of the weight.*

The quantity of extension in consequence of the imperfect elasticity of the fibres of materials is very irregular, and after a certain deflection has been obtained, it is subject to no determinate law; but while the weight or strain upon the fibres is considerably less that that which is required to produce fracture, the law of deflection for each case is nearly uniform, and proportional to the exacting force.

When beams are of the same length, the deflection of one, the weight being suspended from one end, compared with that of a beam uniformly loaded, is as 8 to 3, and when a beam is supported at both ends, the deflection in like cases is as 5 to 8.

Whence, if a beam is in the first case supported in the middle and the ends permitted to deflect, and in the second, the ends supported and the middle permitted to descend, the deflection in the two cases is as 3 to 5.

Of three equal and similar beams, one inclined upward, one inclined downward at the same angle, and the other horizontal, it has been determined that that which had its angle upward was the weakest, the one which declined was the strongest, and the one horizontal was a mean between the two.

When a beam is *uniformly loaded,* the deflection is as the weight, and approximately as the cube of the length, or as the square of the length, and the element of deflection and the strain on the beam, the weight being the same, will be but one-half of that when the weight is suspended from one end.

The deflection of a beam *fixed at one end and loaded at the other,* compared to that of a beam of twice the length *supported at both ends and loaded in the middle,* the strain being the same, is as 2 to 1, and when the length and the loads are the same, the deflection will be as 16 to 1, for the strain will be four times greater on the beam fixed at one end than on the one supported at both ends; therefore all other things being the same, the element of deflection will be four times greater: also, as the deflection is as the element of deflection into the square of the length, *then,* as the lengths at which the weights are borne in their cases are as 1 to 2: the deflection is as 1 : $\overline{2^2 \times 4}$ = 1 to 16.

The deflection of a beam having the section of a triangle, and supported at its ends, is one-third greater when the edge of the angle is up, than when it is down.

When the length is uniform, with the same weight, the deflection will be inversely as the breadth and square of the depth into the element of deflection, which is itself inversely as the depth. *Hence,* every thing else being the same, the deflection will vary inversely as the breadth and cube of the depth.

Illustration.—The deflections of two pine battens, of uniform breadth and depth, and equally loaded, but of the lengths of 3 and 6 feet, were as 1 to 7·8.

If a beam is cylindrical, the deflection is 1·7 times that of a square beam, other things being equal.

The following are the deductions of Mr. Barlow consequent upon the preceding:

When a Beam is fixed at one end and loaded at the other

$$\frac{l^3\,W}{b\,d^3\,D} = V, \text{ a constant quantity.}$$

When a Beam is fixed at one end and uniformly loaded

$$\frac{3\,l^3\,W}{8\,b\,d^3\,D} = V.$$

When fixed at both ends and loaded in the middle

$$\frac{l^3\,W}{24\,b\,d^3\,D} = V.$$

When supported at both ends and loaded in the middle

$$\frac{l^3\,W}{16\,b\,d^3\,D} = V.$$

When supported at both ends and uniformly loaded

$$\frac{5\,l^3\,W}{8 \times 16\,b\,d^3\,D} = V.$$

When supported in the middle and the ends uniformly loaded

$$\frac{3\,l^3\,W}{5 \times 16\,b\,d^3\,D} = V.$$

When supported at both ends and the weight suspended from any other point than the middle

$$\frac{m^2\,n^2\,W}{l\,b\,d^3\,D} = V.$$

l representing the length in inches, b its breadth, d its depth, W the weight or strain with which it is loaded, $m\,n$ the distances of the weight from the supports, and D the deflection in inches.

Hence, in order to preserve the same stiffness in beams, the depth must be increased in the same proportion as the length, the breadth remaining constant.

The deflection of different beams arising from their own weight, having their several dimensions proportional, will be as the square of either of their like dimensions.

Note.—In the construction of models on a scale, intended to be executed in full dimensions, this resnlt should be kept in view.

With regard to the ultimate deflection of beams before their rupture, the same relations do not exist, as when the depth is the same, the element of deflection will, in the breaking state of a beam, be constant; consequenly, the ultimate deflection will, in this case, be as the square of the length, and it will be inversely as the depth, when the length is the same; and if both these dimensions remain constant, the last deflection will be constant also, whatever may be the breadth of the beam.

(*To be continued.*)

* See *Barlow on Materials and Construction,* p. 67.

STRENGTH OF CAST IRON AND WROUGHT IRON PILLARS.

(*Continued from page 34.*)

Tables showing the calculated breaking weight and safe weight of uniform solid cylindrical pillars of cast iron, and the calculated weight of metal contained in each pillar.

Formula for the breaking weight of solid pillars of cast iron, their length or height exceeding 25 times their diameters, both ends of the pillars being flat and firmly fixed :—

$$W = 44{\cdot}16 \frac{D^{3{\cdot}55}}{L^{1{\cdot}7}}.$$

The following formulæ, although not given by Mr. Hodgkinson, are applicable for the safe weight of solid pillars of cast iron, the length or height of the pillars exceeding 25 times their diameters.

For the safe weight, both ends of the pillars being flat and firmly fixed :—

$$W = 11{\cdot}04 \frac{D^{3{\cdot}55}}{L^{1{\cdot}7}}$$

For the safe weight, if irregularly fixed :

$$W = 4{\cdot}416 \frac{D^{3{\cdot}55}}{L^{1{\cdot}7}}$$

Note.—The co-efficient of 4·416 in this formula is, perhaps, rather too low.

Solid Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat, and firmly fixed.

Length or height of Pillar in feet.	Number of diams. contained in the length or height.	Diameter in inches.	Calculated weight of metal contained in the Pillar, in lbs.	Calculated breaking weight in tons from formula, $W = 44{\cdot}16 \frac{D^{3{\cdot}55}}{L^{1{\cdot}7}}$	Calculated breaking weight in tons from formula, $Y = \frac{b\,c}{b + \frac{3}{4}c}$	Safe weight in tons.	Safe weight if irregularly fixed, in tons.
5	30	2	49·13	33·52	...	8·38	3·35
6	36	2	58·95	24·58	...	6·14	2·45
7	42	2	68·78	18·91	...	4·72	1·89
8	48	2	78·61	15·07	...	3·76	1·50
9	54	2	70·43	12·34	...	3·08	1·23
10	60	2	98·26	10·31	...	2·57	1·03
11	66	2	108·08	8·77	...	2·19	0·87
12	72	2	117·91	7·56	...	1·89	0·75
13	78	2	127·74	6·60	...	1·65	0·66
14	84	2	137·56	5·82	...	1·45	0·58
15	90	2	147·39	5·17	...	1·29	0·51
16	96	2	157·22	4·64	...	1·16	0·46
17	102	2	167·04	4·18	...	1·04	0·41
18	108	2	176·87	3·79	...	0·94	0·37
19	114	2	186·69	3·46	...	0·86	0·34
20	120	2	196·52	3·17	...	0·79	0·31
5	24	2½	76·77	...	69·99	17·49	6·99
6	28·8	2½	92·12	54·32	...	13·58	5·43
7	33·6	2½	107·47	41·79	...	10·44	4·17
8	38·4	2½	122·83	33·30	...	8·32	3·33
9	43·2	2½	138·18	27·26	...	6·81	2·72
10	48	2½	153·54	22·79	...	5·69	2·27
11	52·8	2½	168·89	19·38	...	4·84	1·93
12	57·6	2½	184·24	16·71	...	4·17	1·67
13	62·4	2½	199·60	14·59	...	3·64	1·45
14	67·2	2½	214·95	12·86	...	3·21	1·28
15	72	2½	230·31	11·44	...	2·86	1·14
16	76·8	2½	245·66	10·25	...	2·56	1·02
17	81·6	2½	261·01	9·24	...	2·31	0·92
18	86·4	2½	276·37	8·39	...	2·09	0·83
19	91·2	2½	291·72	7·65	...	1·91	0·76
20	96	2½	307·08	7·01	...	1·75	0·70

Solid Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat and firmly fixed.

Length or height of Pillar in feet.	Number of diams. contained in the length or height.	Diameter in inches.	Calculated weight of metal contained in the Pillar, in lbs.	Calculated breaking weight in tons from formula, $W = 44{\cdot}16 \frac{D^{3{\cdot}55}}{L^{1{\cdot}7}}$	Calculated breaking weight in tons from formula, $Y = \frac{b\,c}{b + \frac{3}{4}c}$	Safe weight in tons.	Safe weight if irregularly fixed, in tons.
5	20	3	110·55	...	122·08	30·52	12·20
6	24	3	132·66	...	98·83	24·70	9·88
7	28	3	154·77	79·81	...	19·95	7·98
8	32	3	176·88	63·60	...	15·90	6·36
9	36	3	198·99	52·06	...	13·01	5·20
10	40	3	221·11	43·52	...	10·88	4·35
11	44	3	243·22	37·01	...	9·25	3·70
12	48	3	265·33	31·92	...	7·98	3·19
13	52	3	287·44	27·86	...	6·96	2·78
14	56	3	309·55	24·56	...	6·14	2·45
15	60	3	331·66	21·84	...	5·46	2·18
16	64	3	353·77	19·57	...	4·89	1·95
17	68	3	375·88	17·65	...	4·41	1·76
18	72	3	397·99	16·02	...	4·00	1·60
19	76	3	420·10	14·61	...	3·65	1·46
20	80	3	442·22	13·39	...	3·34	1·33
5	17·142	3½	150·49	...	192·70	48·17	19·27
6	20·571	3½	180·58	...	158·62	39·65	15·86
7	24	3½	210·68	...	132·32	33·08	13·23
8	27·428	3½	240·78	109·95	...	27·48	10·99
9	30·859	3½	270·88	90·00	...	22·50	9·00
10	34·285	3½	300·98	75·24	...	18·81	7·52
11	37·714	3½	331·07	63·99	...	15·99	6·39
12	41·142	3½	361·17	55·19	...	13·79	5·51
13	44·571	3½	391·22	48·17	...	12·04	4·81
14	48	3½	421·37	42·46	...	10·61	4·24
15	51·428	3½	451·47	37·76	...	9·44	3·77
16	54·857	3½	481·56	33·84	...	8·46	3·38
17	58·284	3½	511·66	30·52	...	7·63	3·05
18	61·714	3½	541·76	27·70	...	6·92	2·77
19	65·142	3½	571·86	25·26	...	6·31	2·52
20	68·571	3½	601·96	23·15	...	5·78	2·31
5	15	4	196·55	...	282·98	70·74	28·29
6	18	4	235·86	...	236·53	59·13	23·65
7	21	4	275·17	...	199·68	49·92	19·96
8	24	4	314·48	...	170·35	42·58	17·03
9	27	4	353·79	144·58	...	36·14	14·45
10	30	4	393·10	120·87	...	30·21	12·08
11	33	4	432·41	102·79	...	25·69	10·27
12	36	4	471·72	88·66	...	22·16	8·86
13	39	4	511·03	77·38	...	19·34	7·73
14	42	4	550·34	68·22	...	17·05	6·82
15	45	4	589·65	60·67	...	15·16	6·06
16	48	4	628·96	54·36	...	13·59	5·43
17	51	4	668·27	49·04	...	12·26	4·90
18	54	4	707·58	44·50	...	11·12	4·45
19	57	4	746·89	40·59	...	10·14	4·05
20	60	4	786·20	37·20	...	9·30	3·72

Solid Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat and firmly fixed.

Length or height of Pillar in feet.	Number of diams. contained in the length or height.	Diameter in inches.	Calculated weight of metal contained in the Pillar, in lbs.	Calculated breaking weight in tons from formula, $W = 44·16 \frac{D^{3·55}}{L^{1·7}}$	Calculated break. weight in tons from formula, $Y = \frac{b\,c}{b + \frac{3}{4}c}$	Safe weight in tons.	Safe weight if irregularly fixed, in tons.
5	13·333	4½	248·77	...	393·64	98·41	39·36
6	16	4½	298·52	...	333·64	83·41	33·36
7	18·666	4½	348·27	...	284·84	71·21	28·48
8	21·333	4½	398·03	...	245·20	61·30	24·52
9	24	4½	447·78	...	212·86	53·21	21·28
10	26·666	4½	497·54	183·62	...	45·90	18·36
11	29·333	4½	547·29	156·15	...	39·03	15·61
12	32	4½	597·04	134·68	...	33·67	13·46
13	34·666	4½	646·80	117·55	...	29·38	11·75
14	37·333	4½	696·55	103·63	...	25·90	10·36
15	40	4½	746·31	92·16	...	23·04	9·21
16	42·666	4½	786·06	82·58	...	20·64	8·25
17	45·333	4½	845·81	74.49	...	18·62	7·44
18	48	4½	895·57	67·60	...	16·90	6·76
19	50·666	4½	945·32	61·66	...	15·41	6·16
20	53·333	4½	995·08	56·51	...	14·12	5·65
5	12	5	307·13	...	525·14	131·28	52·51
6	14·4	5	368·55	...	450·75	112·68	45·07
7	16·8	5	429·98	...	388·84	97·21	38·88
8	19·2	5	491·40	...	337·58	84·39	33·75
9	21·6	5	552·83	...	295·11	73·77	29·51
10	24	5	614·26	...	259·78	64·94	25·97
11	26·4	5	675·68	226·98	...	56·74	22·69
12	28·8	5	737·11	195·77	...	48·94	19·57
13	31·2	5	798·53	170·87	...	42·71	17·08
14	33·6	5	859·96	150·64	...	37·66	15·06
15	36	5	921·39	133·97	...	33·49	13·39
16	38·4	5	982·81	120·05	...	30·01	12·00
17	40·8	5	1044·24	108·29	...	27·07	10·82
11	43·2	5	1105·66	98·26	...	24·56	9·82
19	45·6	5	1167·09	89·63	...	22·40	8·96
20	48	5	1228·52	82·15	...	20·53	8·21
5	10	6	442·26	...	851·39	212·84	85·13
6	12	6	530·71	...	746·79	186·69	74·67
7	14	6	618·76	...	656·17	164·04	65·61
8	16	6	707·61	...	578·56	144·64	57·85
9	18	6	796·06	...	512·41	128·10	51·24
10	20	6	884·52	...	456·04	114·01	45·60
11	22	6	972·97	...	407·91	101·97	40·79
12	24	6	1061·42	...	366·66	91·66	36·66
13	26	6	1149·87	326·40	...	81·60	32·64
14	28	6	1238·32	287·76	...	71·94	28·77
15	30	6	1326·78	255·92	...	63·98	25·59
16	32	6	1415·23	229·32	...	57·33	22·93
17	34	6	1503·68	206·86	...	51·71	20·68
18	36	6	1592·13	187·71	...	46·92	18·77
19	38	6	1680·58	171·22	...	42·80	17·12
20	40	6	1769·04	156·93	...	39·23	15·69

Hollow Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat, and firmly fixed.

Length or height of Pillar in feet.	Number of diams. contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formula, $W = 44·34 \frac{D^{3·55} - d^{3·55}}{L^{1·7}}$	Calculated break. weight in tons from formula, $Y = \frac{b\,c}{b + \frac{3}{4}c}$	Safe weight in tons.
8	12	8	6½	427·52	...	530·06	132·51
9	13½	8	6½	480·96	...	490·19	122·54
10	15	8	6½	534·40	...	453·32	113·33
11	16½	8	6½	587·84	...	419·48	104·87
12	18	8	6½	641·28	...	388·57	97·14
13	19½	8	6½	694·72	...	360·32	90·08
14	21	8	6½	748·17	...	334·81	83·70
15	22½	8	6½	801·61	...	311·54	77·88
16	24	8	6½	845·05	...	290·39	72·59
17	25½	8	6½	908·49	...	271·16	67·79
18	27	8	6½	961·93	...	253·67	63·41
19	28½	8	6½	1015·37	...	237·71	59·42
20	30	8	6½	1068·81	...	223·15	55·78
21	31½	8	6½	1122·25	...	209·84	52·46
22	33	8	9½	1175·69	194·04	...	48·51
23	34½	8	6½	1229·13	179·92	...	44·98
24	36	8	6½	1282·57	167·36	...	41·84
25	37½	8	6½	1336·01	156·14	...	39·03
26	39	8	6½	1389·45	146·07	...	36·51
27	40½	8	6½	1442·89	136·99	...	34·24
28	42	8	6½	1496·33	128·78	...	32·19
29	43½	8	6½	1549·78	121·32	...	30·33
30	45	8	6½	1603·22	114·52	...	28·63
8	10⅔	9	7½	486·49	...	645·89	161·47
9	12	9	7½	547·30	...	602·84	150·71
10	13⅓	9	7½	608·11	...	562·33	140·58
11	14⅔	9	7½	668·92	...	524·52	131·13
12	16	9	7½	729·74	...	489·45	122·36
13	17⅓	9	7½	790·55	...	457·04	114·26
14	18⅔	9	7½	851·36	...	427·20	106·80
15	20	9	7½	912·17	...	399·76	99·94
16	21⅓	9	7½	972·98	...	374·54	93·63
17	22⅔	9	7½	1033·80	...	351·38	87·84
18	24	9	7½	1094·61	...	330·13	82·53
19	25⅓	9	7½	1155·42	...	310·58	77·64
20	26⅔	9	7½	1216·23	...	292·61	73·15
21	28	9	7½	1277·04	...	276·07	69·01
22	29⅓	9	7½	1337·85	...	260·82	65·20
23	30⅔	9	7½	1398·67	...	246·76	61·44
24	32	9	7½	1459·48	232·32	...	58·08
25	33⅓	9	7½	1520·29	216·75	...	54·18
26	34⅔	9	7½	1581·10	202·76	...	50·69
27	36	9	7½	1641·91	190·17	...	47·54
28	37⅓	9	7½	1702·73	179·46	...	44·86
29	38⅔	9	7½	1763·54	168·41	...	42·10
30	40	9	7½	1824·35	158·97	...	39·74

(*To be continued.*)

INSTITUTION OF MECHANICAL ENGINEERS.

ON THE MANUFACTURE OF CAST STEEL AND ITS APPLICATION TO CONSTRUCTIVE PURPOSES.

By Mr. Henry Bessemer, of London.

(Illustrated by Plate 208.)

The mode of manufacturing cast steel, which now forms so important a branch of the Sheffield trade, was discovered in the year 1740 by Mr. Benjamin Huntsman, of Handsworth, near Sheffield; who subsequently established steel works at Attercliffe, where his most valuable invention has ever since been successfully carried on. In its early stages many difficulties had doubtless to be overcome; materials for lining the furnaces and for making the crucibles had to be sought for and tested; the peculiar marks of iron most suitable for melting had to be determined ou by numerous experimental trials; and such was the difficulty at that time of making crucibles which would stand the excessive heat of melted steel that for a long period only very highly carbonised or "double converted" steel, which required the lowest temperature, conld be successfully melted. The first products of a new manufacture, even while the invention still remains in a partially developed state, but too frequently stamp its subsequent character. Thus Huntsman's cast steel, although it was acknowledged to be a pure homogeneous metal of great value for certain purposes, was still looked upon as a hard and brittle material of very limited use, not bearing a high temperature without falling to pieces, and quite incapable of being welded; even within the last few years this has been the popular idea of cast steel. Improvements in its manufacture have, however, from time to time been introduced; and steel of a milder and less brittle character has long been made, capable of welding with facility and working at a high temperature without falling to pieces. Its uses have consequently been greatly extended, and the employment of cast steel for the best cutlery and edge-tools has now become universal; indeed the excellent quality of the cast steel at present made in Sheffield for these purposes is scarcely to be surpassed. Of late years several of the most enterprising manufacturers have sought to introduce cast steel for a variety of other purposes besides those for which it was originally employed, and it is now used in some form or other in almost every first-class machine. Its employment as a material for founding bells and various other articles in clay moulds, as carried out by Messrs. Naylor and Vickers, and the introduction of a valuable material by Messrs. Howell and Shortridge, under the name of homogeneous metal, are prominent examples of the successful adaptation of cast steel to engineering purposes.

The manufacture of cast steel by Huntsman's process is so extensively practised and is so well known that it is unnecessary to do more than recall to mind that crude pig iron has first to go through all the stages of melting, refining, puddling, hammering, and rolling, in order to produce a bar of malleable iron as nearly pure as the most careful manipulation in charcoal fires can make it. Bar iron, on which so much labour, fuel, and engine power have been expended, thus becomes the raw material of this most expensive manufacture. In order to convert the wrought iron bars into blister steel, they are packed with powdered charcoal in large firebrick chests, and are exposed to a white heat for several days; the time required for heating and cooling them extending over a period of 15 to 20 days. When thus converted into blister steel they are broken into small pieces and sorted according to the quality of the steel, which sometimes differs even in the same bar. For melting this material powerful air furnaces are employed, containing two crucibles, into each of which are put about 40lbs. of the broken blistered steel. In about 3 hours the pots are removed from the furnaces, and the melted steel is poured into iron moulds and formed into ingots of cast steel, from $3\frac{1}{2}$ to 4 tons of hard coke being consumed for each ton of metal thus melted. When large masses of steel are required, a great many crucibles must be got ready all at the same moment, and a continuous stream of the melted metal from the several crucibles must be kept up until the ingot is completed, since any cessation of the pouring would entirely spoil it; hence in proportion to the size of the ingot are the cost and risk of its production increased. The ordinary manufacture of cast steel is therefore obviously conducted at a great disadvantage. If cast steel is to supersede wrought iron for engineering purposes, it will be necessary to cease employing wrought iron as a raw material for this otherwise most expensive mode of manufacture.

The extremely high temperature requisite to maintain malleable iron in a state of fusion has from the earliest period of the history of iron down almost to the present day rendered its purification in a fluid state practically and commercially impossible. Hence arise all those imperfections to which bar iron is subject, every small piece consisting of numerous granules partially separated from each other by scoria, and every large mass being produced only by piling together small bars, with the inevitable result of increasing the former imperfections; for no two pieces of iron can be brought to a welding heat without becoming coated with oxide, and when this coating is rendered fluid by welding sand a fluid silicate of the oxide of iron is formed, covering the entire surface to be united. The heavy blows of the hammer or the pressure of the rolls may and do extrude the greater portion of this fluid extraneous matter, but it is never wholly removed from between the welded surfaces, and hence a portion of the cohesive force of the metal is lost at every such junction. When a bar of iron is nicked on one side and bent, the rendering open of the pile clearly shows this want of perfect cohesion. Nor is this the only difficulty to be encountered; for in the production of large masses of wrought iron it is necessary to raise the temperature nearly to the fusing point, in order to render each additional piece sufficiently soft and plastic to become united to the bloom: this softening of the iron induces a molecular change in the structure of the metal; its natural tendency to crystallise is so powerfully assisted by the long continuance of the high temperature that its whole structure undergoes a change; large and well defined crystals are formed almost independent of each other, and cohering so feebly to the other contiguous crystals as in some cases to separate with as little force as would overcome the cohesion of ordinary cast iron. In the substitution of the cast steel for malleable iron, both these sources of difficulty are escaped: for the mass whether of 1 ton or 20 tons weight may be formed in a fluid state into a single block, wholly free from admixture of scoria, while it is perfectly and equally coherent at every part; and the forging of such a solid block of metal into shape is only the work of a few hours, and as there is no welding of separate pieces it may be worked under the hammer at a temperature at which no molecular change will take place, the metal being far below its fusing point and much too solid to undergo that destructive crystallisation so common in large masses of wrought iron. Thus the difficulties and uncertainty attending the production of all large masses of wrought iron are wholly avoided in producing equally large masses of cast steel.

But however desirable in the abstract it may be to employ cast steel as a substitute for malleable iron for engineering purposes, it must not be forgotten that there are several important conditions indispensable to its general use. Firstly, the steel must be able to bear a good white heat without falling to pieces under the hammer; otherwise the process of shaping it will not only be expensive, but the partly finished forging may be spoiled at any moment by being overheated. Secondly, the steel should be of such a tough character as to admit of being twisted or bent into almost any form in its cold state before fracture takes place, whether the force be applied as a gradual strain or by a sudden impact. Thirdly, it should have a tensile strength at least 50 per cent. greater than that of the best marks of English iron. Fourthly, it must especially be soft enough to turn well in the lathe, to bore easily, and to yield readily to the file and chisel, so as not to enchance its original cost by the difficulty of working it into the requisite forms. The last is both commercially and practically an important condition, and one which will in future greatly determine the extent of its use. Steel to the engineer has hitherto stood in much the same relation as granite to the builder: the superior hardness, beauty of polish, and durability of granite as compared with other building stone are universally acknowledged, nature has provided it in great profusion, and it has only to be lifted from the earth and made use of; but the practical man has found that to drill a hole in granite for blasting takes days of labour to accomplish, that the stone blunts all the chisels, defies the saw, and is faced only at a great cost; hence the builder goes on using an inferior soft stone, over which the tools have perfect command. The problem to be solved, therefore, is how to produce cast steel that will take any form in the mould or under the hammer, that will yield quickly and readily to all the present cutting and shaping machines, and will retain all the toughness of the best iron with a much greater tensile strength, and all the clearness of surface, beauty of finish, and durability that so eminently distinguished the harder and more refractory qualities of the steel in common use.

These desirable objects are believed by the author to be fully accomplished by his process of converting crude pig iron into cast steel at a single operation, forming the subject of the present paper. This process has now been in daily operation in Sheffield for the last two years. The apparatus by which it is effected is shown in Plate 208, which represents the arrangement at Messrs. John Brown and Co.'s, Atlas Steel Works, Sheffield : Fig. 1, is a side elevation, and Figs. 3 and 4, a front elevation and plan.

The crude pig iron chiefly used in this process has been the hot-blast hæmatite pig smelted with coke, which is melted in a reverberatory furnace adjoining, and is then run into the converting vessel A, Figs. 1 and 3, in which its conversion into steel is to be effected. The converting vessel is shown enlarged in section in Fig. 5, which represents its position in filling, the melted pig iron being run into it by the spout B direct from the furnace. It is made of stout boiler plate and lined with a powdered silicious stone found in the neighbourhood of Sheffield, below the coal, and known as " ganister." The rapid destruction of the lining of the converting vessel was one of the great difficulties met with in the early stages of the invention : the excessive temperature generated in the vessel, together with the solvent action of the fluid slags was found to dissolve the best firebrick so rapidly that sometimes as much as 2in. thickness would be lost from the lining of the vessel during the 30 minutes required to convert a a single charge of iron into steel. The ganister now used however is not only much cheaper than fire-bricks, costing only about 11*s*. per ton in the powdered state, but it is also very durable: a portion of the lining of the vessel is shown which has stood 96 consecutive conversions before its removal. The converting vessel A is mounted on bearings which rest on stout iron standards CC, Figs. 3 and 4, and by means of the gearing and handle D it may be turned into any required position. There is an opening at the top for filling and pouring out the metal; and at the bottom of the vessel are inserted seven fireclay tuyeres, Fig. 9, each having seven holes, as shown enlarged in the longitudinal section and plan, Figs. 10 and 11. The blast from the engine is conveyed through one of the bearings E of the vessel, Fig. 3, into the tuyere box F, and enters the tuyeres at a pressure of about 14lbs. per square inch, which is more than sufficient to prevent the fluid metal from entering the tuyeres.

Before commencing with the first charge of metal, the interior of the converting vessel is thoroughly heated by coke, with a blast through the tuyeres to urge the fire ; when sufficiently heated it is turned upside down and all the unburnt coke falls out. The vessel is then turned into the position shown in Fig. 5, and the melted pig iron is run in from the furnace by the spout B, the vessel being kept in such a position during the time it is being filled that the holes of the tuyeres are above the surface of the metal. When the proper charge of iron has been run in, the blast is turned on and the vessel quickly moved up into the position shown in Fig. 6. The blast now rushes upwards into the fluid metal from each of the 49 holes of the tuyeres, producing a most violent agitation of the whole mass. The silicium, always present in greater or less quantities in pig iron, is first attacked, and unites readily with the oxygen of the air, producing silicic acid; at the same time a small portion of the iron undergoes oxidation, and hence a fluid silicate of the oxide of iron is formed, a little carbon being simultaneously burnt off. The heat is thus gradually increased until nearly the whole of the silicium is oxidised, which generally takes place in about 12 minutes from the commencement of the process. The carbon of the pig iron now begins to unite more freely with the oxygen of the air, producing at first a small flame, which rapidly increases, and in about three minutes from its first appearance a most intense combustion is going on ; the metal rises higher and higher in the vessel, sometimes occupying more than double its former space, and in this frothy fluid state it presents an enormous surface to the action of the air, which unites rapidly with the carbon contained in the crude iron and produces a most intense combustion, the whole mass being in fact a perfect mixture of metal and fire. The carbon is now burnt off so rapidly as to produce a series of harmless explosions, throwing out the fluid slag in great quantities; while the combustion of the gases is so perfect that a voluminous white flame rushes from the mouth of the vessel, illuminating the whole building and indicating to the practised eye the precise condition of the metal inside. The blowing may thus be left off whenever the number of minutes from the commencement and the appearance of the flame indicate the required quality of metal. This is the mode preferred in working the process in Sweden. But at the works in Sheffield it is preferred to continue blowing the metal beyond this stage, until the flame suddenly drops, which it does just on the approach of the metal to the condition of malleable iron ; a small measured quantity of charcoal pig iron containing a known proportion of carbon is then added, and thus steel is produced of any desired degree of carburation, the process having occupied about 28 minutes altogether from the commencement. The converting vessel is tipped forwards, and the blast shut off for adding this small charge of pig iron, after which the blast is turned on again for a few seconds.

The vessel is then turned into the position shown in Fig. 7, and the fluid steel run into the casting ladle, G, which is carried by the hydraulic crane H, being counterbalanced by the weight I, on the opposite end of the jib. When all the metal is poured out of the converting vessel, the crane is raised by water pressure and turned round, as shown in Fig. 2, for the purpose of running the steel into the ingot moulds K. Instead of tilting the casting ladle for pouring into the moulds, it is made with a hole in the bottom fitted with a fireclay seating L, Fig. 8, and closed by a conical plug of fireclay M, forming a conical valve. The valve rod N is coated with loam and bent over at the top, and works in guides on the outside of the ladle, as shown in Fig. 7, with a handle O for opening and closing the valve. By thus tapping the metal from below, no scoria or other floating impurities are allowed to run into the mould, and the stream of fluid steel is dropped straight down the centre of the mould right to the bottom, without coming in contact with the sides of the mould. The moulds are made of a slightly tapered form, as shown in Fig. 8, so that as the ingot contracts in cooling it liberates itself from the mould completely on all sides ; and the mould is removed by being lifted off the ingot when sufficiently set. The moulds are arranged in the moulding pit in an arc of the circle described by the casting ladle, as shown in the plan, Fig. 4.

By this process from 1 to 10 tons of crude iron may be converted into cast steel in 30 minutes, without employing any fuel except that required for melting the pig iron and for the preliminary heating of the converting vessel, the process being effected entirely without manipulation. The loss on the weight of crude iron is from 14 to 18 per cent. with English iron worked in small quantities ; but the result of working with a purer iron in Sweden has been carefully noted for two consecutive weeks, and the loss on the weight of fluid iron tapped from the blast furnace was ascertained to be only 8¾ per cent. The largest sized apparatus at present erected is that in use at the Atlas Steel Works, Sheffield, as shown in the drawings already described, the converting vessel being capable of converting 4 tons at a time, which it converts into cast steel in 28 minutes. In consequence of the increased size of the converting vessel in this case no metal is thrown out during conversion ; and the loss of weight has fallen as low as 10 per cent., including the loss in melting the pig iron in the reverberatory furnace.

Specimens of this manufacture, as carried on at the author's works in Sheffield, are exhibited, consisting of a piece of the pig iron employed, which is No. 1 hot-blast hæmatite made with coke ; also a portion of an ingot of very mild cast steel, broken under the hammer to show the purity and soundness of the metal in its cast unhammered state; and an ingot partly forged to show how little work with the hammer will produce a forging from these solid blooms of steel. There are also two pieces of steel of the quality employed for making piston rods, which have been bent cold under a heavy steam hammer to show the toughness of the metal; it requires very much more force to bend it than would be required to bend wrought iron, but notwithstanding this additional rigidity it yields to any extent without snapping. The tensile strength of this soft and easily wrought metal is as much as 40 tons per square inch, or from 15 to 18 tons greater than that of best Yorkshire iron. In turning, planing, boring, and tapping, it will be found that the uniformity of its quality will be less trying to the cutting tools than the hard reeds and sand cracks met with in the common qualities of malleable iron. The above tensile strength of the piston-rod steel however is by no means the maximum, but on the contrary is nearly the minimum strength of the steel converted by this process; but at the same time it possesses nearly a maximum degree of toughness, for every additional ton in tensile strength obtained by the addition of carbon hardens the steel for working, renders it more difficult to forge, and brings it nearer to that undesirable state when a sudden blow snaps it like a piece of cast iron.

The extreme limits of tensile strength of the converted metal are shown in the following tables, which give the results of many trials made at different times at the Royal Arsenal at Woolwich under the superintendence of Colonel Wilmot :—

BESSEMER STEEL.

Tensile Strength per square inch.

Bessemer Steel.	Various Trials.	Mean Tensile Strength.
	lbs.	
In the cast, unhammered state.	42,780 48,892 57,295 61,667 64,015 72,503 77,808 79,223	63,023 lbs. = 28·13 tons per square inch.
After hammering or rolling	136,490 145,512 146,676 156,862 158,899 162,970 162,974	152,912 lbs. = 68·26 tons per square inch.

BESSEMER IRON.

Tensile Strength per square inch.

Bessemer Iron.	Various Trials.	Mean Tensile Strength.
	lbs.	
In the cast, unhammered state.	38,197 40,234 41,584 42,908 43,290	41,243 lbs. = 18·41 tons per square inch.
After hammering or rolling	64,059 65,253 75,598 76,195 82,110	72,643 lbs. = 32·43 tons per square inch.
Flat Ingot rolled into Boiler Plate without piling	63,591 63,688 72,896 73,103	68,319 lbs. = 30·50 tons per square inch.

From these tables it is seen that, after hammering or rolling, the steel or highly carbonised metal exhibits a mean tensile strength of 68 tons per square inch, but from its hardness and unyielding nature it is totally unfit for many purposes; while the iron or entirely decarbonised metal is so soft and copper-like in its texture as to yield to a mean tensile strain of 32 tons per square inch, a point unnecessarily low except in cases where a metal approaching copper in softness is required. The soft easy-working tough metal of the quality used for piston rods is therefore believed by the author to be the most appropriate material for general purposes, while the hard steels that range up to a tensile strain of 50 or 60 tons per square inch should be avoided as altogether too expensive to work and too dangerous to be employed in any case where sudden strains may be brought upon them.

With reference to the employment of the mild cast steel for constructive purposes, there are few applications of more importance than that which has recently and successfully been made to the construction of steam boilers. The Cornish boiler, as improved by Mr. Adamson, of Hyde, near Manchester, has a large flue tube constructed with narrow plates more than 12ft. long, extending round the flue in one length, and flanged at each edge in a manner which, while it adds greatly to the stability of the flue, demands such qualities in the material employed for its manufacture as are completely found only in metal that has undergone fusion and has become perfectly homogeneous throughout. A practical illustration of the excellence of this mode of constructing boilers, and the powerful strains which the new steel is capable of sustaining safely, is afforded by the steam boilers employed for some time past at Messrs. Platt's works at Oldham, where six of these boilers are in daily use; they are 30ft. long and 6½ft. diameter, and the flue is 4ft. diameter; the plates are $\frac{5}{16}$ in. thick, and the working pressure 100lbs. per square inch.

The advantages of cast steel are still more marked in the construction of the fireboxes of locomotive engines. The difficulty of flanging and shaping this work in plate iron without splitting the metal at some part is so great as to have rendered the employment of copper necessary hitherto for this purpose; but the shape required can now be obtained with ease and certainty by hammering up a sheet of metal rolled from one of the cast ingots, such as that now exhibited. One of these firebox plates flanged by Mr. Adamson is also shown, and clearly illustrates the facility with which the new metal may, under skilful hands, be wrought into any required form. The perfect continuity of the material and its entire freedom from joinings or weldings also obviously render it specially suitable for the tube plates of locomotive engines; for however near the holes are made to one another, there is no danger of their having a flaw or other weak place between them. This is exemplified in the piece of plate now exhibited, in which rivet holes have been punched so close as to remove almost all the metal, without splitting the narrow piece still left between the holes. Nor is it in the construction of the boiler alone that the cast steel may be employed with advantage in locomotives: the the axles whether plain or cranked, the piston rods and guide bars, and last, but not least, the wheel tyres, are all exposed to so much abrasion and to such sudden and powerful strains that a tough strong material capable of withstanding this destructive wear and tear is imperatively demanded for the satisfactory construction and economical working of the engine.

The special aim of the author during the first year of his labours, which throughout the last six years has never been lost sight of, was the production of a malleable metal peculiarly suitable for the manufacture of ordnance. By means of the process that has been described, solid blocks of malleable cast steel may be made of any required size from 1 to 20 or 30 tons weight, with a degree of rapidity and cheapness previously unknown. The metal can also with the utmost facility be made of any amount of carburation and tensile strength that may be found most desirable; commencing at the top of the scale with a quality of steel that is too hard to bore and too brittle to use for ordnance, it can with ease and certainty be made to pass from that degree of hardness by almost imperceptible gradations downwards towards malleable iron, becoming at every stage of decarburation more easy to work and more and more tough and pliable, until it becomes at last pure decarbonised iron, possessing a copper-like degree of toughness not found in any iron produced by puddling. Between these extremes of temper the metal most suitable for ordnance must be found; and all qualities are equally cheap and easy of production.

From the practice now acquired in forging cast steel ordnance at the author's works in Sheffield it has been found that the most satisfactory results are obtained with metal of the same soft description as that employed for making piston rods. With this degree of toughness the bursting of the gun becomes almost imposible, its power of resisting a tensile strain being at least 15 tons per square inch greater than that of the best English bar iron. Every gun before leaving the works has a piece cut off the end, which is roughly forged into a bar of 2 inches by 3 inches section, and bent cold under the hammer in order to show the state of the metal after forging. Several test bars cut from the ends of guns recently forged are exhibited.

The power of this metal to resist a sudden and powerful strain is well illustrated by the piece of gun muzzle now shown, which is one of several tubular pieces that were subjected to a sudden crushing force at the Royal Arsenal, Woolwich, under the direction of Colonel Wilmot; the pieces were laid on the anvil block in a perfectly cold state, and were crushed flat by the falling of the steam hammer, but none of them exhibited any signs of fracture when so tested. Probably the best proof of the power of the metal to resist a sudden violent strain was afforded by some experiments made at Liège by order of the Belgian government, who had one of the guns bored for a 12lb. spherical shot of 4¾ inches diameter, and made so thin as to weigh only 9¼ cwts. This gun was fired with increasing charges of powder and an additional shot after each three discharges, until it reached a maximum of 6¾lbs. of powder and eight shots of 12lbs. each or 96lbs. of shot, the shots being thus equal to about one tenth of the weight of the gun. It stood this heavy charge twice and then gave way at about 40in. from the muzzle, probably owing to the jamming of the shots. The employment of guns so excessively light and charges so extremely heavy would of course never be attempted in practice.

Some idea of the facility of this mode of making cast steel ordnance is afforded by the time occupied in the fabrication of the 18 pounder gun now exhibited, which was made in the author's presence for his experiments on gunnery. The melted pig iron was tapped from the reverberatory furnace at 11.30 A.M., and converted into cast steel in 30 minutes; the ingot was cast in an iron mould 16in. square by 4ft. long, and was forged while still hot from the casting operation. By this mode of treating the ingots their central parts are sufficiently soft to receive the full effect of the hammer. At 7 P.M. the forging was completed and the gun ready for the boring mill.

The erection of the necessary apparatus for the production of steel by this process, on a scale capable of converting from crude iron enough steel to make forty of such gun blocks per day, will not exceed a cost of £5000, including the blast engine; hence the author cannot but feel that his labours in this direction have been crowned with entire success; the great rapidity of production, the cheapness of the material, and its strength and durability, all adapt it for the construction of every species of ordnance.

For the practical engineer enough has already been said to show how important is the application of cast steel to constructive purposes, and how this valuable material may be both cast and forged with such facility and at a cost so moderate as to produce by its superior durability and extreme lightness an economy in its use as compared with iron. The construction of cast steel girders and bridges, and of marine engine shafts, cranks, screw propellers, anchors, and railway wheels, are all deserving of careful attention. The manufacturer of cast steel has only to produce at a moderate cost the various qualities of steel required for constructive purposes to ensure its rapid introduction; for as certainly as the age of iron superseded that of bronze, so will the age of steel succeed that of iron.

ROYAL SCOTTISH SOCIETY OF ARTS, 1861.

ON THE DETERMINATION OF THE FORM OF A SHIP'S HULL BY MEANS OF AN ANALYTIC EXPRESSION.

By Edward Sang, C.E., F.R.S.E., Edinburgh.

The investigation of that shape of a floating body which shall encounter the least resistance when moving through the fluid, is attended with difficulties of the highest order; so much so that, while many other problems of mechanical optimism have been resolved, this one has scarcely been more than glanced at.

Unable, with all the aids which the higher calculus can give us, to discover the laws which regulate the motions of the particles of a disturbed fluid, we are stopped at the very threshold of the inquiry; and any slight attempts that have been made to penetrate the obscurity which shrouds the whole subject, have had to be founded on gratuitous assumptions.

When such is the case with regard merely to headway resistance, the problem "to discover the best form for a ship's hull" must be hopelessly intricate, seeing that many other matters have to be taken into consideration. Thus, the power of carrying sail before the wind or on a tack, the resistance to leeway, the rolling, the pitching, and sundry etceteras, have to be added to the essential requisite,—the combination of speed with tonnage.

If we were able to put all these conditions in the shape of equations, and thence to deduce the optimum form, that result would necessarily be expressed by an analytic equation of the general type $\phi(x, y, z) = 0$, indicating a relation among the three co-ordinates x, y, z of each point in the surface.

Now, it is a general feature of lines or surfaces obtained from algebraic formulæ, or from mechanical or geometrical geneses, that their curvature changes gradually from point to point. They have no harsh angular turnings, nor yet any abrupt transitions from one kind of curve to another; wherfore, we may safely conclude that smoothness and beauty of lining must characterise the optimum form of a ship's hull. A conviction of this truth is practically expressed by the great care which naval architects bestow upon their ship's lines.

The beauty of lines obtained from mechanical geneses may be illustrated by a few examples. If we twist one side of an elastic rubber packing-ring, as if trying to turn it inside-out, the ring takes and keeps a gracefully waved form, its edges exhibiting four lines of double curvature most beautifully combined. Or if, having attached a polished ball to one end of a wire, we secure the other end in a vice, and cause the wire to vibrate, the path which it transverses, made visible by the reflection of a light from the polished surface, takes singularly graceful forms, passing gradually from one phase to another.

Again, to come nearer to our present subject, if, keeping two slender rods as under by a stay at a little distance from their middles, we bring the ends together, there results the form of the caïque, well known to combine elegance with swiftness in rowing; but possessing the disadvantages of rolling heavily, of drifting to leeward, so as not to lie within ten points of the wind, and of being unmanageable right before the wind. But if, instead of merely bringing the ends together, we lace them tightly, we obtain the type of the Northmen's boat, capable of tacking within five points of the wind, as well as of sailing before it.

Though we be unable to deduce, by a synthetic process, the best form from the known laws of hydraulics, it does not follow that we are debarred from attempting to representing the hull of a ship by means of an equation. Long experience and many trials have led shipbuilders to certain classes of forms, as combining the various qualities which are desirable, and it is but reasonable to suppose that the improvements which have been introduced tend in the direction of optimism; so that the proposition "to discover some inconsistent genesis from which the whole details of the outward form may be deduced," may well be entertained, both on account of the possibility of its solution, and of the important aid which it may be expected to give us.

This view of the matter forced itself upon my mind while attending the lectures of Professor Leslie in 1821; and I made many attempts without being able to obtain a formula giving even a rough approximation to what was wanted. From time to time these attempts were repeated, and at last the subject was dropped in despair. Three and thirty years afterwards, while engaged with some speculations in a very different branch of science, an idea occured to me which led to the renewal of my early trials, and I have ultimately found a class of analytic expressions, representing with wonderful fidelity the various forms that have been in use.

The well-known plasticity, if we may so call it, of analytic formulæ may be exemplified by the ordinary complete equation of the third degree, viz.,

$$\mathrm{A}x^3 + \mathrm{B}x^2y + \mathrm{C}x^2z + \mathrm{D}xy^2 + \mathrm{E}xyz + \mathrm{F}xz^2 \, \mathrm{G}y^3 + \mathrm{H}y^2z + \mathrm{I}yz^2 + \mathrm{K}z^3 + \mathrm{L}x^2 + \mathrm{M}xy + \mathrm{N}xz + \mathrm{O}y^2 + \mathrm{P}yz + \mathrm{Q}z^2 + \mathrm{R}x + \mathrm{S}y + \mathrm{T}z + \mathrm{V} = 0,$$

which represents a variety of curved surfaces so great that even the classes of them can hardly be enumerated; or by the mechanical equations $x = a \sin pt$; $y = b \sin(qt + u)$; $z = c \sin(rt + v)$, which, by changes in the values of a, b, c, p, q, r, u, v, may be made to give any one of the endless variety of curves produced by the simple vibrations of elastic bodies.

The equations which represent the hull of a ship, and which I propose to designate by the name of *sefinet* equations,—are even more plastic; only a minute proportion of the forms produced by them being applicable to the purposes of naval architecture.

In order to obtain a complete mastery over these formulæ, I have projected a series of models, for which various values are to be assigned to the constants. The first of these, intended to represent a clipper ship, has been finished, and may serve to show with what degree of fidelity the formula may be made to bring out the desired shape. As was to be expected of a first trial, this model presents some slight peculiarities which it is desirable to amend. For this purpose, the effects produced by a change in the constants of the formula are studied, the calculus of variations being used, if need be, and thence new values are obtained, so as to bring out, or press inwards, the surface to the required degree. In this way the second trial may give us exactly what is wanted.

These remarks, and an inspection of the model, are sufficient, in my opinion, to confirm the assertion, that the representation of a ship's hull by means of an analytic formula is possible. I now proceed to point out some of the advantages of the system.

The first class of advantages are those which it gives to the designer. When the general dimensions and character of a vessel have been resolved on, the design is usually worked out somewhat in this way: A model is made by binding firmly together a number of layers of wood; this mass, having been fashioned by chisels and gouges to please the eye, is finished with rasps and sand-paper. When these layers are separated, they show the horizontal sections or water-lines, which are afterwards magnified on the full-sized moulding-floor.

From these horizontal sections the vertical or frame sections are projected. Any irregularities which may be observed in these are remedied; thence the water-lines are retouched; and this process of alternate amendment is continued until the designer be satisfied. For greater security, sections by vertical planes parallel to the keel, and also diagonal sections, are sometimes taken; and when all these lines have been made smooth the design is complete. These tedious operations are but the practical enunciation of the well-known law, that every section of an analytically determined curved surface is an analytic curve.

The algebraic process is this: The general outlines in plan, profile, and transverse section having been sketched out, and the characters of the stem and stern determined on, a formula is made up under the guidance of previous experience. From this formula the leading sections are computed. If these be unsatisfactory, the formula is amended, the computations are repeated, but for a greater number of points and sections, and thus a satisfactory result is obtained.

When the constants have been finally settled, any required section, horizontal, transverse, longitudinal, or oblique, can be computed, and that to any required degree of precision.

The formula thus, so far from being a restraint, becomes a tool, by help of which the designer can carry out his idea in the most perfect manner. In itself there is no particular leaning to one kind of shape rather than to another. It produces indifferently a round, a sharp, a bottle-nosed stem; a flat bottom or a sharp keel; rounded sides, as in the model, or sides so flattened as to deviate imperceptibly from straight lines. What it most resolutely and effectively performs is this: It produces a surface gradually curved in every direction, a consistent whole; the bow being no longer on one principle, the middle on a second, and the stem on a third scheme.

The next class of advantages are those affecting the actual construction of the ship.

The most convenient manner of recording the calculations is this: Two sets of parallel lines are traced upon the sheer section—one set horizontally, the other vertically—at such distances as may be thought convenient; the half-breadth of the hull at each crossing is computed and recorded at the proper place.

From this table it is easy to deduce and to delineate the size and shape of each component part of the structure. The levels, the curvatures, and every other detail, can be obtained with much greater ease and precision than by the old method, so that the builder is no longer under the necessity of having a full-sized drawing, any more than the architect of St. Paul's needing a drawing-board as long and as broad as St. Paul's Church-yard.

The frames and ties may be all finished apart, may be stored up until the building-slip be empty, and may then be at once put together, so that *per annum* a greater number of vessels may be turned out of the building-yard than at present. Nay, it is possible to compute and trace out the forms of the planks —to mark even the holes for the trenails or rivets; thus leaving little more than edge-dressing to be done at the ship's side.

The table of dimensions is in the most convenient form for computing the displacements at different depths, the position of the centre of gravity, and the times of rolling and pitching. These are, indeed, deducible directly from the formula; but the necessary integrations present difficulties perhaps insuperable.

The third class of advantages are connected with the general improvement of naval architecture.

The only way open to us for discovering those laws which ought to regulate the formation of ships intended for different services, is to watch narrowly the performances, and to contrast these with the peculiarities of vessels actually built.

Models are of little or no use, for we cannot infer from the performance of a small, what would be that of a large craft similar in shape. It is more than probable that in this, as in other departments of mechanics, a change of size requires to be accompanied by a change in the proportions. A glance at the formation of marine animals may satisfy us on this point. Among the small fishes and crustacea we find great dissimilarity and great complexity of structure. As we ascend in the scale of size, the forms become simpler and less varied, till the large amphibious mammalia, the seals and the whales, become almost identical in general outline with the true fishes,—the fore-paddles doing the work of the pectoral fins, the hind-flappers replacing the tails.

While adverting to this subject, I cannot resist the temptation to remark, that the general sefinet equation may be made to produce even the forms of fishes. Though prevented by the pressure of business from having made the trials, I feel confident of obtaining the shapes of the salmon, herring or cod (minus, of course, the fins), nearly enough to satisfy ichthyologists themselves.

Now, so long as ships are made by what is called "rule of thumb," we have the greatest difficulty in tabulating our experience. The length, breadth, and depth may be given; the tonnage and the area of the midship section; but along with these we want the peculiarities of the stem and stern, and, for the behaviour in a heavy sea, the dimensions and configurations of the parts above the water-line. All that we can do is to give names to the acknowledged classes of shapes, and to enter them in our record-book.

But when the shapes of vessels shall have been determined algebraically, the elements of the formula can be recorded against the performances of the ships, and definite conclusions may be drawn. Thus, when the spread of canvas, its position on the spars, the pressure of the wind, coupled with the results in tacking and scudding, shall have been observed for ships of different formulæ, we shall be able to make up what are called *equations of condition*, by help of which the best forms for general service or for particular destinations may be safely determined.

Nor need the first experiments be made at hap-hazard; we can take, as our starting-point in the race of improvement, the very best models that have hitherto been found, while the essays at amendment may be made with the utmost caution, since we can alter the data of our formulæ by the most minute quantities.

I do not think that I am over-sanguine in expressing the hope, that the adoption of the sefinet method may soon change naval architecture, from being a business of mere taste and guess-work, to be a branch, and a very important branch, of exact science.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary meeting, November 26th, 1861. J. P. JOULE, LL.D., President, in the Chair.

Mr. Joseph Sidebotham exhibited a photograph of the contorted schists seen in the cliff near the South Stack Lighthouse, Holyhead.

Mr. John Parry showed some photographs of fossil woods from the South Lancashire coal field. These displayed beautifully the structure, even to the most minute vessels.

A Paper was read by Mr. E. W. Binney, F.R.S., Vice-President, entitled "Additional Observations on the Permian Beds of South Lancashire." This was a continuation of two previous papers read before the Society, and printed in its Memoirs.* Since that time the author has made further observations on the Permain strata at Heaton Norris, near Stockport: Medlock Vale, between Ashton and Manchester; Chorlton-upon-Medlock, and Ordsal, near Manchester; and Skillaw Clough and Bently Brook, near Newburgh, in the West of Lancashire.

At Heaton Norris, in the sand delf of Mr. Howard, near the railway station, the lower new red sandstone was seen dipping to the south-west at an angle of 25°. This was succeeded by red and variegated marls having a similar dip. These last named strata were overlaped by the Trias, which dips to the south-west at an angle of 12°.

At Heaton Mersey the following section was met with:

	Feet.
Trias	45
Permian—Red and variegated marls containing limestones	129
Lower new red sandstone grooved	402
	576

The Permain beds were cut off by a fault near the railway station at Heaton Norris, first shown to me by Mr. Hull, B.A., F.G.S., of the Geological Survey, which brought in the Trias. This rock occupied the district between that town and Goyt's Hall, in the Marple valley, where the lower part of the middle coal measures was seen in nearly a vertical position.

The author considered that Mr. Howard's sand delf is a likely place for ascertaining the existence of a coal field under the town of Stockport worth working.

The next was a section made by Mr. John Wood, at Medlock Vale, between Waterhouses, near Ashton-under-Lyne, and Manchester. It was as follows:

	Feet	In.
Drift	26	0
Trias	23	0
Permain—Red marls, with beds of limestone and five beds of gypsum	246	3
Lower new red sandstone	375	11
Coal measures ......about	99	0
	761	2

What these coal measures were, whether above or under the Bradford Four Feet Mine, it was at present impossible to say; but it was to be hoped that some mine would be met with to enable us to determine the value of the great tract of coal measures lying between Ashton-under-Lyne, Oldham, Middleton, and Manchester. Mr. Wood had done more than any other gentleman to clear up this point, and it was to be desired that he should meet with a good seam of coal, both for his own sake and that of the public.

The third section mentioned was at the sugar works of Messrs. Fryer and Co., in Chester-street, Chorlton-on-Medlock, Manchester. The following beds were there met with:

*Vols. xii. and xiv. (New Series) of the Society's Memoirs.

	Feet.
Trias	114
Permian—Red marls with limestones	237
Coarse red sandstone with pebbles	45
Coarse red sandstone	24
Coal measures consisting of red shaly marls and limestones (Ardwick)	126
	546

The limestones in the last named strata contained specimens of *microconchus carbonarius* and scales of *palæoniscus*, which clearly proved them to be similar beds to those of the upper coal field at Ardwick, to which they bear every resemblance in physical charaeter.

The occurrence of coal measures on the south side of the city of Manchester is quite new and of great importance, showing that such strata at places are met with under permian and trias deposits much nearer the surface than was previously suspected, and where the upper rocks gave no evidence of their proximity. The above bore has proved beyond doubt that a band of coal measures lies under the south of Chorlton-on-Medlock; and possibly extends to Heaton Norris, being probably brought up by the great Pendleton fault, which most likely passes through the south of Manchester and joins the fault seen near the railway station at Heaton Norris previously alluded to, and described more fully in the paper.

In the fourth section, at Ordsal, Messrs. Worrall found the trias beds 460 feet in thickness without going through them. At the bottom of the bore the water became so salt that they discontinued the work, it being no longer fit for dyeing and such like purposes. This is the first instance, to the author's knowledge, where salt water has been met with in the trias near Manchester.

The fifth and sixth sections were at Skillaw Clough and Bentley Brook to the north of the Newburgh station on the Manchester and Southport Railway. These were some time since discovered by Mr. E. Hull, B.A., F.G.S., of the Geological Survey, and described shortly by that gentleman in the sheet explaining the map of the district. Further particulars were given of the details of both sections, and an analysis of the limestone was produced, which showed it to differ in its chemical characters from the thin ribbon bands found in the permian marls near Manchester, Patricroft, Astley, and Leigh, and was very like the yellow magnesian found at Stank, in Furness, North Lancashire. Probably it might prove to be a different bed, and more like the great central deposit of magnesian limestone of Yorkshire than the thin beds previously alluded to.

REVIEWS AND NOTICES OF NEW BOOKS.

A Manual of Civil Engineering. By WILLIAM JOHN MACQUORN RANKINE, C.E., LL.D., F.R.S. Lond. and Edin., &c. London: Griffin, Bohn, & Co., 1862.

Agreeably to the promise we made in our last number, we now resume our notice, and we cannot do better than cite the preface for the purpose of conveying accurately the nature of the contents, aud the divisions the author has adopted. He says:—

"This work is divided into three parts. The first relates to those branches of the operations of engineering which depend on geometrical principles alone, that is to say, Surveying, Levelling, and the Setting-out of Works, comprehended under the general name of Engineering Geodesy, or Field-Work. The second part relates to the properties of the Materials used in engineering works, such as earth, stone, timber, and iron; aud the art of forming them into Structures of different kinds, such as excavations, embankments, bridges, &c. The third part, under the head of Combined Structures, sets forth the principles according to which the structures described in the second part are combined into extensive works of engineering, such as Roads, Railways, River Improvements, Water-Works, Canals, Sea Defences, Harbours, &c.

"The first chapter of the second part, entitled 'A Summary of the Principles of Stability and Strength' forms not so much an integral part of the book, as a collection of mechanical principles and formulæ, introduced for the sake of being conveniently referred to in the subsequent chapters, so as to prevent their being encumbered with mathetical investigations to a greater extent than is absolutely necessary.

"The third part, so far as the details of the designing and execution of works are concerned, consists, to a great extent, of references to the first and second parts, its special object being to explain those principles which are peculiar to each class of great works of engineering, and which regulate the general plan of such works.

"The tables of the strength of materials at the end of the volume give, as regards iron and stone, average and extreme results only. Detailed information as to the strength of different kinds of stone and iron is given in the course of the text, under the proper headings.

"I have, throughout the book, adhered to a systematic arrangement as far as was practicable, and have only departed from it in a few instances, when it became necessary to introduce questions that had arisen, or facts that had been ascertained, after the completion of the part of the work to which they properly belonged. In drawing up the table of contents and the alphabetical index care has been taken to show where such detached pieces of information are to be found. "W. J. M. R.

"*Glasgow College, 6th January,* 1862."

In Part I., chapter one is devoted to general explanations relating to Engineering Geodesy, or Field Work, than which nothing can be clearer or more ably explained in detail; the same observations apply to the following chapters relating to surveying by the chain, and surveying by angular measurements:—chapter four is devoted to levelling generally; chapter five to setting-out, and all the details of working section and level book, &c.

Chapter six refers to marine surveying for engineering purposes, and chapter seven is devoted to the subjects of *copying, enlarging, and reducing plans.*

All the foregoing are treated by the author with his usual minuteness and clearness of style.

In Part II., however, the author is thoroughly in his element in dealing with the principles of stability and strength. 480 pages are devoted to this part of the work, and it is difficult to say to *how many* published works devoted to these subjects, a careful student would have to refer for the same amount of information which is condensed within the limited space here devoted to these subjects.

Part III. refers to what the author defines as Combined Structures; chapter one treating of Lines of Land Carriage; chapter two of the Conveyance and Distribution of Water; chapter three of Works of Inland Navigation; and chapter four of Tidal and Coast Works.

What we have said of the "Applied Mechanics" and "The Steam Engine," by the same author, in praise of the excellence of those works applies with still greater force to the present admirable work, which, for the amount of valuable information it contains, and the small price at which it is published, places it at the head of engineering books of reference, and recommends it to not only the students in Civil Engineering, but to masters of the profession.

Giornale dell'Ingegnere Architetto Ed. Agronome. By Raffaelle Pareto. Milan: 1861-1862.

We have received the last volume of this Italian Engineering periodical, which is published in Milan, in numbers every two months. It contains some excellent illustrations of engineering constructions and architectural works. The text consists of numerous interesting papers and valuable contributions to practical science, and gives evidence of the great interest taken in these subjects in the kingdom of Italy. There are some very good examples of iron bridge building, as also some plates of Harbour Improvements, which are highly creditable.

The subscription price is 28 Italian lire per annum for numbers delivered free in England.

The Year Book of Facts in Science and Art, &c. By John Timbs, F.S.A London: Lockwood and Co., Stationer's Hall Court, 1862.

The volume for 1862, has for a frontispiece a life-like portrait of Mr. William Fairbairn, L.L.D., F.R.S., &c., and contains a brief memoir of that gentleman. The portrait is engraved on steel from an excellent photograph by Messrs. Hills and Saunders, of Oxford.

Mr. Timbs has, as usual, accumulated and published a vast amount of very interesting and valuable information connected with the various branches of art science, and manufactures. Indeed, everything worthy of note which occurred or was announced during the year 1861, appears to have been seized on and arranged in convenient order. For some years past, a reference to Mr. Timbs' annual volume, for any particular occurrence, has materially abridged the amount of labour usually necessary in pursuing a search after facts, and we know of no better means of tracing back the history of discovery and invention, than by a reference to Mr. Timbs' very useful *Year Book of Facts*

The obituary, or list of persons eminent in science and arts, who departed this life during the year 1861, has been very carefully compiled.

Spithead Forts: Reply to the Royal Commissioners' Second Report on our National Defences. By Capt. Cowper Phipps Coles, R.N. Somerset College, Ventnor, Isle of Wight. London: Mitchells, Charing-cross, 1861.

Capt. Coles, in a pamphlet of thirty-four pages, falls foul of the Royal Commissioners and the two Reports issued in connection with the question of the defences of the ports and harbours of Great Britain, and he contrasts the recommendations contained in those reports and calls attention to "the contradictions and inconsistences of the two reports issued by the Commissioners, and the great absence of their practical bearing." We do not quite understand Capt. Coles' views upon the subject from his pamphlet, but we believe he advocates the armour plating of steam ships of war in opposition to the erection of forts for the protection of our harbours.

THE OIL SPRINGS OF CANADA AND THE UNITED STATES.

In our last number we gave an article on "Mineral Oils for Illumination," in which the oil wells of the United States and Canada were alluded to. Since then the following particulars have appeared in the *Times*, which we deem sufficiently interesting to merit a place in our columns:—

The production of oil from the springs in Canada and the United States continues on a scale far greater than the means of transport. At present the refining trade as regards this product seems in a state of only partial organisation, and the difficulties and cost of conveyance delay its development. Every fresh account, however, seems to indicate that the supply is virtually illimitable, and that the result will be the growth of a new business, which, for rapidity and extent, will be such as has rarely been paralleled in the history of commercial changes. Hitherto the arrivals in Europe have not been large; but a vessel has just discharged 5,000 barrels in Victoria Dock, and several additional cargoes are daily expected, both here and at Liverpool. The New England houses are gradually withdrawing themselves from the sperm oil trade, with the view of investing their capital in the establishment of refineries (a change in which they have been assisted by the opportunity of selling some of their old vessels to the Government for the stone blockade at Charleston) and they now appear to have commenced making consignments, especially from Boston, with some degree of regularity. To check this competition the Paraffine patent owners in the United Kingdom have commenced a suit in Chancery to prevent the use of that name for the American manufacture. The article, however, must be wholly independent of the name under which it is offered, and will find its market solely according to its claims on the score of quality and cheapness. An increase in purity is being constantly effected by the daily experience from its enlarged manufacture, but the question of price cannot be tested until the requisite facilities of transport shall have been established. The prime cost at present is actually almost nominal, but there are 30 miles of bad roads to be traversed before the oil can be placed on the railway either for New York or Boston, and the expenses and difficulties of cartage are enormous. The hardening of the roads by a sharp frost will occasionally make all the difference between very large profits or a direct loss to the well owners. Lately the oil has been sold at the wells for a sum equal to 1*s.* per barrel, and an instance is mentioned of a lot of several hundred barrels having been disposed of at 11*s.*, barrels included. Under such circumstances it is only the wells that flow spontaneously to the surface that can be worked at a profit, but these yield a seemingly inexhaustible quantity. In the course of less than half-a-year, however, direct railway communication, both in Canada and Pennsylvania, will, it is said, be established into the heart of the principal regions. In Canada the directors of the Great Western line are directing their attention to the requisite measures, and in Pennsylvania an extension of the Atlantic and Great Western line, which connects with the Erie Railway to New York, is stated to have been already commenced to the principal seat of the business, with the certainty of completion in the course of the ensuing spring. Meanwhile the entire district, which a few years back was little more than a wilderness, is becoming thickly peopled, notwithstanding the interference of the war with commercial operations of all kinds. The following are the latest particulars given in the Philadelphia journals:—

"The coal oil of Pennsylvania is rapidly becoming one of the most important elements of our industry and wealth. It is scarcely three years old, and even now it bids fair to rival the coal trade itself. The following statement of the shipments on the Philadelphia and Erie Railroad alone will give a comparative idea of the increase of this trade:—In 1859, 325 barrels; in 1860, 21,794 barrels; in 1861, 134,927 barrels; while for the first month of 1862 the total shipments on this road have been estimated at 30,000 barrels. Large as the business and the increase on this railroad has been, it is estimated that it shows but little more than one-sixth of the business actually done. Large quantities of the oil were taken to Pittsburg by way of the Alleghany River, and thence to Philadelphia by the Pennsylvania Railroad. The Erie Extension Canal carried large quantities to Erie, whence it found its way to the eastern market by the lake and the railroads in North-western Pennsylvania. It is stated on good authority that the wells on Oil Creek yield 75,000 barrels of crude oil per month, which would be 900,000 per annum. What the yield of the whole oil region in this State will be during the present year cannot be definitely ascertained, but it must reach very considerably over a million barrels of crude oil, for new wells are continually being opened, and the trade is making the most astonishing strides, and promises greater wonders still. It has no parallel in this country or in the world, except the Californian gold fever, which it rivals in speculation and excitement. The crude oil, it is said, involves an expense of about 10 dols. per barrel in purchasing barrels, transportation, refining, &c., so that the actual expenditure on 1,000,000 of barrels would be 10,000,000 dols. per annum. The region of country in which such immense wealth is now being developed was, before the excitement caused by 'striking oil,' comparatively thinly populated, and much of it a wilderness, but now it is becoming thickly settled, and new towns are springing up, and old ones growing into greater proportions. This will make that section one of the most flourishing in the commonwealth, while all the oil seeking an Eastern market and an outlet for Europe must greatly benefit and increase the trade of Philadelphia, the emporium of the State."

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

SAFETY HAVENS FOR MINERS.

(*To the Editor of the* ARTIZAN.)

SIR,—Colliery proprietors are now impressed with the necessity of having two shafts to every pit, or at least, a staple (communication) between upper and lower seams of coal, the want of which caused the fatality at the late sad accident at the Hartley pit. Permit me to suggest another safety retreat, which would protect the lives of the miners. A brattice (division of a shaft) generally occasions sufficient ventilation in a pit to enable men to work in any part. When a brattice is disarranged, the upward current of gas and downward passage of air cease, and probably at the same time, the mode for pitmen leaving is cut off. Imprisoned miners should then have the facility of escaping to especially prepared places in all the seams, where they might safely assemble and wait for relief. This object would be secured by embedding under the casing that surrounds the perpendicular sides of a shaft, a diaphragmatic or a double concentric pipe, laid from the outer air to the spots chosen as "Havens of Safety," which would be thus ventilated perefectly distinct from, and independent of, the mode adopted for the rest of the underground workings. This plan is often adopted for ventilating particular rooms in buildings. At each of the prepared places there should be the facility of closing the ventilating branch pipes in seams where there are no men at work. G.W.

NOTICES TO CORRESPONDENTS.

ELECTRUS.—You are unintelligible, write distinctly and we will endeavour to reply.

ATLANTIC.—The steamer *Royal William*, of 180 H.P. and 1000 tons burden, was built at "Three Rivers" on the St. Lawrence, by Canadian mechanics, and was fitted with Canadian engines. She sailed in 1833, from Picton, Nova Scotia, to Cowes, Isle of Wight, and she was regularly employed for four years between Liverpool and Ireland, and afterwards made some voyages between Liverpool and America. Refer to the back volumes of the ARTIZAN for the particulars of the *British Queen*, *President*, and other steamers.

APPRENTICE.—The Niagara Railway Suspension Bridge was opened for traffic on the 18th of March, 1855. It was constructed by Mr. John Roebling, an American engineer, we believe of Trenton, New Jersey. There is a fourpenny book, *Hardwicke's Elementary Mechanics* (192, Piccadilly), and which we recommend for your study.

G. H. (Newcastle).—Send the drawing and specification and we will do our best.

TENSILE.—51,000lbs. is usually adopted for convenience of calculation, as the strength of the iron is somewhere about 23 tons per square inch (51,520lbs). This you might have discovered for yourself. For the semi-steel 58,240lbs. was low. Are you not in error, as if only 26 tons per square inch it must have been poor stuff.

S. H. (Bolton).—Answered by post. The *James Watt* has, we believe, two single acting air-pumps, say about 10 cubic feet together.

W. R. O.—(Sunderland).—Continue for another year or two, and then, have a couple of years in the office of a civil engineer.

S. D.—(Victoria, Vancouver).—We are unable to reply to your enquiries, but hope to do so within two months.—We believe that it is proposed to follow the course of some valley, between the lake Superior, and the lake Winnipeg, and along Assiniboia, but from thence the line is not defined, the surveys appear very imperfect. We do not know if the river Saskatchwan, has been navigated for the purposes of survey.

A SUBSCRIBER (Burnley).—You are quite "at sea;" purchase one of Weale's Series: *The Steam Engine*, or Professor Rankine's work, *The Steam Engine and other Prime Movers*, published by Griffin and Bohn, Stationers' Hall-court, London, and you will be spared the trouble of making such an enquiry as that contained in your letter of February 14th. If, however, you have a particular case to which you wish us to give an answer as to what is the the N.H.P. of the engine by Watt's rule, we will send you the answer after your furnishing us with the dimensions, &c.

CAPT. R. N., LOW PRESSURE, AND YOUNG STEAM.—We recommend you to obtain two books, the one by Messrs. Main and Browne of Portsmouth, and the other by Capt. T. Miller of Her Majesty's steamship *Clio*, both excellent works (for your purpose,) on the Marine Engine, and both may be had at Messrs. Spons', Bucklersbury.

ALFRED C.—The best means of obtaining the information you require is to purchase *Abstracts of the Principal Lines of Spirit Levelling throughout the Kingdom, made during the last eighteen years for the construction of the Ordnance Maps*, by Col. Sir Henry James, R.E., F.R.S., &c. London: Vacher and Sons.

D.—1st. We have been able to discover that Mr. Jaffray, now of the Hartlepool Iron Works, applied the Feed-water Heaters some years before the date of the patent to which you refer. 2nd. You had better apply to Messrs. Caird and Co., Greenock. 3rd. Messrs. Scott, Sinclair & Co., was the firm, no doubt, to which reference is made. Send your address and state the object of your enquiry, we will then inform you more.

D. (Hamburgh).—You had better write to Messrs. C. and W. Earle, of Hull, or apply to Mr. James Oldham, C.E., Hull, for the information required.

PRACTICAL ENGINEER (Manchester).—We thank you for the suggestion. Can you direct our attention to anything really worth giving in the way of illustrations of improved stationary engines and boilers? We find it exceedingly difficult. We have two examples which were engraved some little time ago. They are very good specimens of designs and of workmanship, but there is nothing particularly novel about them.

BOGIE ENGINE.—There are some defects in the plan you suggest for constructing bogie frames. We will look into the subject. There are two bogie engines, —we believe the first two which have been introduced north of the Tweed,— at work upon the Great North of Scotland Railway, under Mr. W. Cowan, C.E.

RAILWAY BILLS.

The examining barristers of the Houses of Lords and Commons have announced that the following Railway Bills have complied with the standing orders:— London and South-Western—widening the existing line near the Vauxhall and Southampton stations; increasing the station accommodation at Nine Elms; and making a railway from Wareham to Knowle, and taking power to raise £500,000 and to borrow £166,600; also for making junction lines to connect the Andover and Redbridge Railway with the London and South-Western, and to lease the former and raise £60,000. South Yorkshire—to enable the company to to construct new railways near Sheffield and Thorne, at a cost of £100,000. Maryport and Carlisle Company to make branch railways to Bolton and Wigton, to enlarge their station there, and to raise £100,000; Inverness and Aberdeen, and Inverness and Rosshire—amalgamation; Brean Down—for the construction of a railway, pier, and harbour at Brean Down, in the Bristol Channel, and to raise £100,000; North Devon—for the construction of a railway dock.

Metropolitan and Thames Valley.—To make new railways through the valley of the Thames from the Great Western Railway to Richmond, Hampton, Shepperton, and Chertsey, at an estimated cost of £250,000. The junction with the Great Western would be near Southall, and run into the South-Western near Twickenham and Kingston-bridge.

South-Eastern.—The widening of the North Kent line at certain points, and also two new lines, one from Deptford to Tunbridge, and another from Lewisham to Dartford, requiring a further capital of £1,200,000.

Manchester, Sheffield, and Lincolnshire.—The bills of this company were for the construction of a Liverpool central station, together with a railway from Toxteth Park to Liverpool, at an estimate of £395,000, and a branch between Godley and Woodley, at £56,000. Barnsley Coal Railway for an extension to Wakefield and Barnsley, and to raise £160,000, and for an amalgamation of the North British, Edinburgh, and Perth, and West of Fife.

Great Western.—For power to construct new railways, the first commencing by a junction with the Birmingham, Wolverhampton, and Dudley at the Handsworth station, and terminating at Smethwick; the second beginning at Bromwich, and terminating at Tipton; and the third commencing at the Hatton station, and joining the Stratford-on-Avon Railway; with power to raise £110,000 on shares and £36,000 on mortgage.

London, Chatham, and Dover.—For a line from Clapham to Battersea, also for tramways to the piers and harbour at Dover. Power to consolidate the sum of £800,000 as second preferential capital of the general undertaking, to raise £800,000 on account of the Farnborough Extension and other works, to form the third preferential capital, to raise £900,000 for the Metropolitan Extensions and £750,000 for the general purposes of the undertaking, the company having incurred, and being about to incur, a very large expenditure for terminal passengers and goods stations and factories, and laying down additional lines on the Metropolitan Extensions.

London and Blackwall.—For widening the existing line in Whitechapel, Cannon-street-road, and Cross-street, and to raise £300,000 by new shares.

Bristol and South-Western Junction.—To authorise the London and South-Western to make eight new lines to unite with the Salisbury and Yeovil, the Midland and the Somerset Central, and to raise a further capital of £750,000.

Vale of Neath, and Swansea and Neath.—By this bill the Vale of Neath purpose to acquire the Swansea and Neath, and to lay down on their own line the narrow gauge, in addition to the broad guage, the cost of the latter being estimated at £100,000 and the remainder at £60,000.

Briton Ferry and Dock Company.—For a lease of the undertaking to the South Wales and Vale of Neath Railway Companies, to raise £30,000 and to borrow £45,000.

Stockton and Darlington.—To make new lines to Towlaw and Crook; to convert the company's existing capital into stock, and apply any portion of it to the new works.

North British and Carlisle and Silloth Bay Companies.—For leasing the latter to the former.

Market Drayton and Newport Junction.

Somerset Central and Dorset Central (amalgamation); Severn and Wye

Great Northern.—To make a line from Rossington, near Doncaster, to Gainsborough, and alter levels from the latter place to Saxelby, with power to raise £333,000 in new shares, and to borrow £110,000.

Norwich and Spalding.—To extend the line from Sutton, in the Holland division of Lincolnshire, by a double junction; to issue new shares to the extent of £75,000 and borrow £25,000.

West Cheshire.—For a new line from Mouldsworth to Chester, and branches to the Birkenhead Railway, with power to raise £200,000 and borrow £60,000.

Vale of Clwyd.—To extend their line to the river Clwyd at Foryd, and to raise £13,000.

Launceston and South Devon.—For a railway from Tavistock to Launceston at an estimated cost of £180,000, and power to borrow £60,000.

Moretonhampstead and South Devon.—From the Newton station of the South Devon to Moretonhampstead, at a cost of £105,000 and £35,000 on loan.

Edgware, Highgate, and London.—For a railway from the Great Northern to Highgate and Edgware. The Great Northern undertakes to subscribe £73,300 towards the proposed capital of £220,000.

Tewkesbury and Malvern.—To enable the company to raise a further sum of £120,000 by preference shares, and £40,000 on loan, and to lease the line to the Midland Railway Company.

Birkenhead.—For a railway from Hooton to Park-gate, and to apply the Birkenhead surplus moneys towards its cost of construction.

West Riding, Hull, and Grimsby.—To make a line from the Bradford, Wakefield, and Leeds, at Wakefield, to the South Yorkshire at Barnby-upon-Don, with branches, at a cost of £360,000.

The Abingdon.—To raise a further capital of £6000.

The Redditch.—To raise £20,000.

The Berwickshire.—To make branch railways.

Frosterly aad Stanhope.—For deviations, and to raise £6,000.

The Bala.—For a line between Corwen and Bala, at £80,000.

The Denbigh, Ruthin, and Corwen.—For subscribing £30,000 to the Bala line.

Eden Valley.—For extensions at a cost of £65,000.

Abbey Holm and Lee Gate and Bolton.—At a cost of £48,000.

Carlisle and Silloth Bay.—To raise a further sum of £100,000.

North British, for the Monkton-Hall and Ormiston and Dalkeith Branches.—To raise £173,000, and to lease the Port Carlisle and Dock.

Greenock and Weymiss Bay.—To make a railway, at a cost of £160,000.

Scottish North-Eastern Junction.—For branches and increased capital of £200,000.

Radstock and Keynsham.—For a line between these places.

The Dundee, Perth, and Dundee and Newtyle.

TheNorth British and Glasgow and South-Western.

West Cheshire Junction.—To make railways from the Birkenhead Docks to the West Cheshire Railway, at an estimated outlay of £600,000.

Alford Valley.—For deviations.

Great North of Scotland.—To subscribe £100,000 to the Formantine and Buchan, and £48,000 to the Alford Valley, and to raise £300,000.

Weymouth and Portland.—To construct a railway from Weymouth to the Isle of Portland, and to extend the Wilts, Somerset and Weymouth Railway to the harbour, and raise £100,000.

Eastern Union.—To raise £250,000, and to subscribe to the Waveney Valley line.

Bristol and Clifton.—For a railway from Bristol to Brandon-hill, near Clifton, with tramways to the quays of Bristol, and to raise £250,000.

Midland.—For new railways in connection with the Rowsley and Buxton line, and to raise £380,000.

London, Brighton, and South Coast.—To enlarge the London Bridge-station on its south-western side in Horseleydown; to enlarge the accommodation of their Bricklayers' Arms station; to provide steamboats between France and England, and raise £350,000 by new shares, and borrow £116,000.

Mid-Kent.—To vest in the Mid-Kent part of the Farnborough Extension and the whole of the Crays line.

Great Northern.—To acquire additional lands for station accommodation at Doncaster.

East Gloucestershire.—For new railways from Cheltenham to Farringdon and Bourton-on-the-Water; to raise £600,000 and borrow £200,000.

London, Chatham, and Dover.—For an extension of the line to Walmer and Deal, for which it is proposed to create new shares to the amount of £150,000, and to borrow £50,000.

Andover and Great Western, and Andover and Redbridge and Southampton.—To connect the Andover and Redbridge railway near Andover with the Great Western at Newbury and to raise an additional capital of £340,000. The second project is to extend the Andover and Redbridge to Southampton Harbour, and carry tramways along it, at an estimated cost of £85,000.

Tottenham and Hampstead.—For a line from the Hampstead Junction Railway to the Eastern Counties at Tottenham, and a branch from the Great Northern at Hornsey, to raise £160,000 in shares and £53,000 on loan.

Whitechurch, Wrexham, and Mold and Connah's Quay Junction, at a cost of £240,000; the Leadburn, Linton, and Dolphinton, in the county of Peebles, at a cost of £53,000; the North British and Carlisle and Siloth Bay, to lease the former to the latter; the North Devon and Okehampton, at the estimated cost of £130,000 and £43,000 on loan.

Bala and Dolgelly.—For a railway between those places, to cost £112,000; Lostwithiel and Fowey, at a cost of £50,000; Bridge of Weir, for lines from Johnstone to bridge of Weir, at £33,000; Corwen, Bala, and Portmadoc, to connect these towns, at a cost of £120,000. Wellington and Cheshire Junction, to unite the counties of Shropshire and Cheshire, at an estimated cost of £420,000. Bradford, Wakefield, and Leeds, for completion of the Orsett branch and deviation at Dewsbury; Dartmouth and Torbay to complete line and raise £72,000; Lancashire and Yorkshire, for new lines near Rochdale and Wigan, and power to provide steamboats and purchase additional lands, requiring a further capital of £333,000 in shares and £111,000 on Mortgage; Ceylon, to dissolve the company; Kington and Eardesley, for a line between these places, in Breconshire at a cost of £100,000; Stockton and Darlington, South Durham and Lancashire, Eden Valley and Frosterley, and Stanhope Amalgamation; Stanford and Essendine, to unite their lines with the London and North-Western and Midland Railways, and raise £60,000; Andover and Redbridge, to raise a further sum of £20,000; Wycombe, to borrow £80,000 for carrying out extensions; the Moldand Wrexham, for extension in Denbigh and Flint, at a cost of £120,000; Birkenhead, Flintshire, and Holyhead, for lines from Hooton to Queen's Ferry and Chester and Holyhead, at a cost of £160,000; South Leicestershire, for deviations; Leeds, Bradford, and Halifax Junction, deviation and extension of Batley branch, and £200,000 new capital; Cromford and High Peak, for lease to the London and North-Western; West Hartlepool, to increase the dock accommodation, and power to raise £900,000 and subscribe £40,000 to the Cleveland Railway; Oldham and Ashton, for lease to Manchester and Sheffield and London and North-Western; Much Wenloch and Severn, to raise £42,000; Merthyr and Tredegar, to lease to the London and North-Western; Hull and Hornsea, for a line between those places; Dundalk and Enniskillen. The South Yorkshire to extend their line to Hull, and to raise £400,000 by new shares; Trent, Ancholme, and Grimsby—to enable the South Yorkshire and Manchester and Sheffield Companies each to contribute £40,000 towards the Trent and Ancholme line, and also to acquire it; Caledonian—to construct new lines from the Granton branch to Leith, with connecting branches, and to raise £150,000 by new shares.

London and North-Western.—To enable the company to construct the following additional railways, viz., a line from Beeston to Farnley Ironworks, in the West Riding of Yorkshire; a line to connect the Chelford and Knutsford line with the Cheshire Midland; a line to connect the Stour Valley with the Birmingham Canal Navigation; an embankment along the north-west side of the old harbour of Holyhead, together with a deviation in the South Leicestershire Railway, and other deviations; to raise an additional capital of £253,000, and to borrow £83,000.

Lancashire and Yorkshire.—To construct railways from Askern Junction to the Rawcliffe station of the Wakefield, Pontefract, and Goole Railway, and from near Goole to the Hull and S by at Cave Sands, to raise £248,000, and borrow £82,000.

Mid-Kent and Addiscombe.—For a railway from Beckenham to Croydon, and to raise £45,000.

Eastern Counties.—For two new lines in Middlesex, the first commencing by a junction with the Northern and Eastern at Tottenham, and terminating by a junction with the North London at Hackney; the second commencing at Edmonton and terminating at Tottenham. To raise on shares £160,000, and to borrow £53,000; also to subscribe to the North London extension £300,000, and £100,000 on loan.

Metropolitan.—To acquire lands and houses in the parishes of St. Sepulchre and St. Botolph, Aldersgate, near the northern side of Long-lane, between Charterhouse-street and Goswell-street, near the western side of Coppice-row, and to raise £300,000 by the creation of preference shares.

Rickmansworth, Amersham, and Chesham.—For a line between these places, with a capital of £91,000 and loan of £31,000, and for arrangements with the London and North-Western.

Eastern Counties.—To vest in the company the powers of the Epping Railway Company, to abandon the railway from Epping to Great Dunmow, to make a railway to Crouch-street, Colchester; to raise £140,000 by shares, and borrow £46,600.

Newport and Ryde.—To construct a railway from Newport to Ryde, in the Isle of Wight, and to raise £100,000.

Cannock Chase Extension.—To make a railway to connect the Cannock Chase Railway with the South Staffordshire Railway, and to raise £40,000.

Midland.—To make the three new railways: the first from Duffield to a junction with Manchester and Midland Railways; the second from Great Bowden, in Leicestershire, to near Market Harborough; and the third from the Bristol and Birmingham to a juction with the Birmingham Extension; to raise a further capital of £120,000 in new shares, and to borrow £40,000.

North-Eastern.—For new lines between Blaydon and Conside, with branches; to raise £165,000, and borrow £55,000.

Bishop's Waltham, Botley, and Bursledon.—For a railway between these points, in connexion with the London and South-Western, at a cost of £60,000.

Garston and Liverpool.—To authorise the abandonment of a portion of the line.

London, Chatham, and Dover and St. Mary Cray.—To lease the line from Bromley to St. Mary Cray to the London, Chatham, and Dover Railway Company, and to issue new shares not exceeding the aggregate capital of the Cray Company.

North-Eastern.—To construct the Team Valley and other branch railways in Durham, to raise £400,000, and to borrow £133,000. The company's second bill is for leasing the Hull and Holderness Railway.

Bishop's Waltham, Bottley, and Bursledon (West Shropshire Mineral).—For making railways, at a cost of £180,000, and to borrow £60,000 on loan.

London Railway Depot and Storehouses (for the relinquishment of the street and railway they were authorised to make by their Act of 1860, in favour of the Corporation of London, who undertaketo do it); Llanidloes and Newton, Mid-Wales,and Manchester and Milford (a joint station at Llanidloes, and to raise £32,000); Edinburgh, Perth, and Dundee, and Fife and Kinross (amalgamation); Newry and Armagh (deviations); Uxbridge and Rickmansworth (deviations); West Midland and Severn Valley (to alter terms of lease;

(to enlarge harbour at Lydney); and Tilbury, London, Southend; Llanelly; Deeside; Great Western and Andover and Redbridge (for leasing the latter to the former); Edingburgh and Glasgow (for a railway to Dunfermline by Queensferry and subsidiary branches, and an increased capital of £250,000); Burton-on-Trent (for a railway between the breweries of Messrs. Bass and the Midland Railway); Keighley and Worth Valley (to raise £48,000); Ulster and Banbridge, Lisburn and Belfast (for leasing the latter to the former); North-Eastern and Newcastle-on-Tyne (amalgamation); Eastern Counties and East Anglian, Eastern Union, Norfolk, and Newmarket (amalgamation); North-Eastern (branches to Hull and Doncaster); to Market Weighton and Beverley; Great Southern and Western and Limerick and Castleconnell, and Hereford (for lease to the London and North Western); the Shrewsbury and Welchpool (to widen and improve their main line and to raise £80,000); the Newtown and Machynleth (to make agreements with the Great Western Company); the Furness (to enable them to make a branch line to Hawcoat Quarry, to vest in them the Ulverstone line, to enable them to purchase and hold steam-vessels, to raise £142,000, and borrow £40,000): Furness and Coniston (amalgamation); Oswestry and Newtown, Llanidloes and Newtown, and Shrewsbury, and Welchpool amalgamation, &c., with London and North-Western; the Parsonstown and Portumna (for an extension to Portumna across the Shannon, and to raise £22,000); the Enniskillen and Bundorn (for an extension to the Midland Great Western at Sligo, and to raise £150,000 and borrow £50,000); the Hereford, Hay, and Brecon (for deviations); the Dare Valley (for a line from Aberdare and branches, at an estimated cost of £40,000); the West Midland (for additional works); the Farringdon.

Edinburgh and Glasgow and Caledonian and Dumbartonshire Junction (amalgamation.)

Merionethshire.—For new lines to Merionethshire.

Llynvi Valley.—For power to raise an additional capital of £40,000 by shares, and to borrow £13,300 on loan.

Mid-Wales.—For making a junction between the Mid-Wales and the Central Wales (Extension) Railways, and for altering the levels of the Mid-Wales line.

South Yorkshire.—To authorise the transfer of the undertaking to the Manchester, Sheffield, and Lincolnshire Company.

Ramsgate, Sandwich, Deal, and Dover.—For a railway between these places.

Great Western, Hereford, Ross, and Gloucester, and Ely Valley (amalgamation); *Daventry*

Banstead and Epsom Downs.—For making a railway from the Sutton station of the Croydon and Epsom Railway to Banstead and Epsom Downs, and to raise for the purpose £85,000 in shares, and £28,300 upon loan.

Kent Coast.—To construct railways or tramways at Ramsgate, and to empower the Board of Trade, if they think fit, to transfer the harbour of Ramsgate to the Kent Coast Company, with power to raise £160,000 on shares, and borrow £53,000.

Bristol Port.—For a railway from the port of Bristol to the old channel at the mouth of the river Avon, and a pier there, the estimated cost of the railway being £86,000, and of the pier £40,000, with power to borrow £41,000.

Spalding and Bourn.—For a railway between these places, and a capital of £130,000.

Caledonian (deviations); Londonderry and Coleraine (arrangements with creditors.)

Isle of Wight.—For a railway from the eastern section to Newport, at an estimated cost of £100,000

Waterford and Passage.—For a line from Waterford to the town of Passage, at a cost of £80,000.

Bristol and South Wales Union.—For a branch to the pier at the mouth of the river Avon, at an estimated cost of £50,000.

London and North-Western, and Chester and Holyhead Railway (for arrangements as to capital).

Drayton Junction.—For a railway between the London and North-Western at Weim, in Shropshire, and Eccleshall, in Stafford, and to raise £200,000.

Aberystwith and Welsh Coast; Abingdon (capital); Brean Down, Ceylon, Dundalk, and Enniskillen; Enniskillen and Bundoran; Great Southern and Western, and Limerick and Castleconnel; Inverness and Aberdeen and Rosshire; Llynvi Valley; Londonderry and Coleraine; Newry and Armagh; Parsonstown and Portumna; Redditch, Ulster, and Belfast; Waterford and Limerick and Ennis; Ellesmere, Oswestry, Ruabon, and Shrewsbury. For the construction of certain railways to give continuous communication from Ellesmere to Oswestry, Ruabon and Shrewsbury, and for constructing a bridge over the River Dee, and to raise £100,000. Dulais Valley Mineral, for the construction of railways in the counties of Glamorgan and Brecon, and to raise £90,000.

Presentation to Mr. Joseph Nichols at Brighton.—On the evening of the 14th ult., a meeting of the employés of the London, Brighton, and South Coast Railway Company, was held in the Reading Room of the Literary and Scientific Institution, for the purpose of presenting a testimonial to Mr. Joseph Nichols, foreman of the locomotive department, who is about leaving Brighton for Leeds. Mr. Molineux presided, and Mr. Nichols occupied a seat to the right of the chair. After the representatives of the turners, smiths, strikers, fitters and others had expressed their great respect to Mr. Nichols, and regret at losing their foreman, the chairman made the presentation which 420 persons had subscribed to, and which consisted of a magnificent gold watch and massive gold chain with the following inscription neatly engraved on the inner case:—"Presented to Mr. Joseph Nichols, as a token of respect and esteem, by his friends and fellow servants of the London, Brighton, and South Coast Railway Company, on his retirement from the service." Mr. Nichols, in a long and able speech, in which he recapitulated the duties of a foreman towards his employers, and towards those under him, returned thanks.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Hills *v.* Evans.—This motion for a decree, which has so recently been before this Court, involved the question as to a patent right claimed by the plaintiff for purifying gas. The patent was granted to the plaintifi on the 28th of November, 1849, for an invention which (as modified by subsequent disclaimer) is entitled "an improved method of manufacturing gas." The infringement was alleged to have been committed by the defendant, Frederick John Evans, in the process patented by him on the 27th of August, 1858, for an invention entitled "an improvement applicable to gas purifying." This process has been in use by the London Gas Light Company and other companies, and has given rise to repeated litigation, which have been duly recorded in the Artizan. The specification of the plaintiff Francis Clark Hills in his letters patent claims—first, the purifying coal gas from sulphurretted hydrogen, cyanogen, and, more or less perfectly, from ammonia, by passing it through the precipitated or hydrated oxides of iron, or the subsulphates or oxychlorides of iron, from whatever source obtained, and either by themselves or made into a more porous material; and, secondly, the repeatedly renovating or reoxidizing the purifying materials by the action of the air, whenever they cease to absorb sulphurretted hydrogen, so that they may be used over and over again to purify the gas; with a third claim, which is not material. The Lord Chancellor, delivered his judgment, and the reason for it, *in extenso*, and commented upon the various authorities bearing on the subject. His Lordship, in substance, said that the construction to be placed upon the specifications of patents, like the construction of other written intstruments, belonged to the Court, but the explanation of the technical terms used in the specifications were by law deemed matters of fact to be decided by a jury upon the evidence adduced before them. Moreover, the direction to the jury by a Judge respecting the construction of the other portions of the specification must be contingent upon the meaning placed by the jury upon such technical terms, and, in addition, the drawing a comparison between two specifications exclusively belonged to a jury. Under such circumstances, if the matter had gone by way of appeal to the Court of Exchequer Chamber in error, the Judges must have held that the question was one of fact, which had already been determined by a jury, and not one of law, over which they had jurisdiction. The case had been argued before him (the Lord Chancellor) as if it were before the Exchequer Chamber, and for the reasons above stated, the judgment must have been in favour of the plaintiff. His judgement, however, would not rest upon that ground alone, for he had allowed the question whether the matters in the specification of the plaintiff's patent had not been made *publici juris* by specifications of patents anterior to the patent of the plaintiff. His Lordship then went most carefully through the various prior specifications referred to in the arguments, and, after commenting upon the technical phraseology of each, said that he had come to the conclusion there was nothing in any such specifications in the smallest degree forestalling, anticipating, or rendering unnecessary the plaintiff's patent, or disentitling him to the benefit of his invention. Another point had been raised against the plaintiff's specification, that it was indefinite in its terms, and bad on account of their generality and inaccuracy, but he (the Lord Chancellor) was of opinion that this objection entirely failed, and that the plaintiff had conclusively established the validity of his patent at law. With respect to the remaining question as to the infringement of the plaintiff's patent by the defendants, the defendants had themselves declined to test the point, and therefore the Court had only to make a declaration that the plaintiff's patent had been finally established at law, and to grant a perpetual injunction in the terms of the prayer of the bill. There would also be a direction for taking the account according to the prayer, and the plaintiff's costs as between solicitor and client would have to be paid by the defendants, except the costs incurred before the Lords Justices. That part of the bill relating to the agreement of 1860 would be dismissed.—Ordered accordingly.

The Great Northern Railway *v.* Behrens.—This case, involving the liability of railway companies as carriers, was tried in the Exchequer chamber. Mr. Behrens, a picture dealer, had brought an action against the Great Northern Railway to recover the value of a picture that was injured in transit on the Great Northen Railway. The defendant had declared the value of the picture, but had not paid the per centage according to the company's conditions, and therefore they contended they were not liable. The Court of Exchequer held that they were liable, because they had not demanded the additional rate. The case was argued last term, and the court took time to consider their judgment. Mr. Justice Wightman now delivered judgment. The respondent having declared the value of the goods was entitled to recover. The person delivering the goods to the company was bound to declare the value, in order to make the carrier responsible, and after that there was nothing to exempt the carrier. The carrier was not bound to accept the goods after that declaration, without payment of the additional rate, but having waived that right it did not get rid of his liability. Judgment of the court below affirmed.

Clark *v.* Holmes.—The Court delivered judgment. The action was brought against the defendant, who was a mill-owner, for injuries. The plaintiff had been in the service of the defendant; and it was his duty to oil the engine, which, when he first entered the defendant's service, was fenced, but which afterwards was broken; and on one occasion, when the plaintiff was attending to the machine, his arm was drawn in and cut off. On the part of the defendant, it was contended that the plaintiff, being the person who attended to the machine, knew the danger, and that the accident was occasioned through his own negligence. At the trial a verdict was found for the plaintiff, the jury being of opinion that there was no negligence on his part, which the Court of Exchequer subsequently upheld. The defendant then appealed against the decision of that court. Their lordships confirmed the opinion of the court below, being of opinion that the negligence was on the part of the part of the defendant, not fencing off the machine. Judgment affirmed accordingly.

Polke *v.* the Great Western Railway Company.—This was an action brought by the plaintiff for an accident. On the 25th of June last the plaintiff was a passenger by the defendants' line, from Paddington to Milford. Upon reaching Grange Court, near Lancaster, the defendants' line runs on to the line of the South Wales Railway Company on its way to Milford, and it was at that spot that the train by which the plaintiff was travelling ran into a truck which was on the line, and occasioned the injuries to the plaintiff of which he complained. At the trial before Mr. Baron Martin, the learned judge was of opinion that the defendants were liable, having contracted to carry the plaintiff safely from London to Milford. On the part of the defendants, it was contended that they were not liable. The accident occured through the negligence of the South Wales Railway Company's servants in leaving a truck upon the line. The defendants had no control over the servants of the South Wales Railway Company, and had nothing to do with them except the trains going from London to Milford ran over their lines. The defendants contracted, and used due care and diligence, but never contracted to carry safely, as Mr. Baron Martin alleged that they had. Under these circumstances, it was contended that Mr. Baron Martin's ruling was wrong. The Court were of opinion that the ruling of Mr. Baron Martin was correct, and affirmed the judgement of the Court below. Judgement affirmed accordingly.

HARWOOD *v.* THE GREAT NORTHERN RAILWAY.—This was an action for the infringement of a patent for fish-joints for railways. The questions were whether the invention was new, and whether it was a good subject matter for a patent. The case has before been argued, but the Court took time for consideration. Mr. Justice Willis delivered the judgment of the Court, reversing that of the Court below, and that the verdict must be entered for the defendants, denying the novelty of the invention.—Judgment reversed.

FORD *v.* THE LONDON AND SOUTH-WESTERN RAILWAY COMPANY.—This was an action brought by the plaintiff, a gentleman residing at Rugby, to recover compensation in damages for injuries sustained through the negligence of the defendant's servants. The defendants pleaded not guilty. It appeared from the evidence adduced on the part of the plaintiff, that on the 28th of January, 1861, he was a passenger by the defendant's line of railway by an express train, which consisted of ten carriages and a break van. The break van, instead of being placed at the end of the line of carriages, was placed between the fourth and fifth. The train proceeded on its journey quite safe until it arrived at the Epsom Junction, when one of the wheels of the tender got off the line, and upon going round a curve which is in the road at that spot three carriages flew off the line and fell down the embankment, and shortly afterwards two flew off in the opposite direction. In one of those carriages the plaintiff was sitting, and he was thrown about very violently and rendered insensible. Eventually he was taken home, and attended by a medical man, who found that two of his ribs were broken, his shoulder was put out, his bladebone had suffered a severe blow, and he was otherwise materially injured. He received the particular attention of his medical man for the space of ten weeks, and he had not done with his assistance yet. The grounds of action of which the plaintiff complained were, first, that the tire of the wheels which went off the line was in an improper state; secondly, that the train was going at too fast a rate; thirdly, that the gauge between the two lines of metals at the curve was in some places wider than others; and, fourthly, that the break-van was in an improper place. The defence was that due and proper care was used on the part of the railway company. The accident was not occasioned by the wheel of the tender getting off the line, but by one of the carriages flying off. As to the second ground of complaint, the defendants contended that the train was an express train, and was not going at a greater speed than 30 miles per hour. As to the third, that the metals would always vary, and that on the best-managed railways they would always be found to vary; and fourthly, that it was only a matter of opinion where the break-van should be placed, but on this occasion some of the carriages were to have been shunted, and therefore it could not have been put nearer to the end than it had been. The learned Judge, in summing up, said that, to find a verdict for the defendants, the jury must find that the company had used the best precautions in known practical use for the safety and comfort of their passengers. The jury retired at five o'clock, and returned into court at a quarter-past six with a verdict for the plaintiff, damages £1,500.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

MR. C. COLWELL'S SYSTEM OF VENTILATION.—Having obtained the permission of the owner of the Montague Main Colliery, at Scotswood, near Newcastle-on-Tyne, Mr. Colwell proceeded, on the 1st. ult., to test his theory of ventilating by means of compressed air. The Montague is the only pit in the great northern coal field at which Mr. Colwell's plan could be tried with facility and trifling expense, inasmuch as it is the only one in that district which is ventilated by the fan. The Montague is at present working the three-quarter seam, the upper, or Beaumont seam, having been wrought out forty years ago, since which period, until recently, the pit has lain dormant. The Beaumont seam is 30 fathom from the surface, and to this point the air is conveyed in boxes about 18in. square. From thence to the Three-quarter seam, a distance of 18 fathoms, the shaft is divided in the ordinary way by means of a brattice, and it was at this point that Mr. Colwell commenced his operations. The upcast shaft was closed with stout planking and clay, until it was as tight as the materials would allow, an aperture of 12in. square being left in the middle. Over this aperture a cover was placed 18in. square, in which was a smaller opening of 2in. square, covered by a flap a little larger. To the upper flap a barometer was suspended for the purpose of registering the pressure. Two men were placed at the bottom of the shaft, and all being ready, the process of filling the pit commenced. At the end of about half-an-hour the barometer was consulted, and it was found that a pressure of ½lb. to the inch had been realised. The clay thrust into the crevices here began to show signs of yielding, and some of it was blown upwards. At the end of the next half-hour the barometer indicated a decrease in the amount of pressure, which Mr. Colwell attributed to the air having by this time forced itself into the goaf. At the end of another hour the barometer registered a pressure of 1lb. to the inch, and as the clay and water which had collected upon the planking was continually being flung upwards, and the situation of the watchers thereby rendered anything but pleasant, the experiment was brought to an end, Mr. Colwell expressing himself perfectly satisfied with the trial. The apparatus being removed, the air rushed up the shaft at a furious rate, and an hour afterwards was found to be coming up in a strong current. The two men stationed at the foot of the shaft said that they once or twice felt a slight tingling in the ears, which they attributed to the noise created by the contending currents of air in the boxes, and they described the ventilation as being admirable. Of course this experiment does not afford evidence of the state of air at the face of the workings, where, and in various other places, barometers were not placed. That the pit was completely filled is, however, to be inferred from the facts that 1lb. pressure was obtained, and that an increased upward current continued to be perceptible for a considerable time after the boarding had been removed.

CORADINE'S SHEET METAL SPLITTING MACHINE.—At the Institution of Engineers in Scotland, a model of this machine was exhibited by the Blochairn Iron Company, and the secretary described its action, explaining that the features of improvement comprised in it were the provisions for dividing a sheet into two or more parallel strips at once, and the contrivances permitting of the easy adjustment of the parts for cutting different widths. The cutters consisted of square-edged steel rings, mounted upon two parallel shafts, and working slightly past each other—the rotation of the shafts causing the cutting rings to draw the sheet through whilst cutting it. The machine, which was of very small size, was shown in action, cutting sheet iron, of about 18-wire gauge, into three strips at once—the strips being delivered with square clean cut edges, and without twist.

THE BOILERS FOR THE EXHIBITION, six in number, each 30ft. × 6ft. 6in. diameter, with two flues through, are being constructed by Messrs. Benjamin Hick and Son, of Bolton, and are being fitted with D. K. Clark's steam jet for preventing smoke.

A TRIAL has been made at Gosselies of a new kind of chain, patented by M. Tonneau, of Jumet. M. Tonneau's chain was 0·72in. in thickness, and was tested against an ordinary chain 1.01in. in thickness. Both chains resisted very well a strain of 17 tons, but on the test being carried further the 1·01in. chain broke at 26 tons. The Tonneau chain was still resisting at a pressure of 35 tons, when the fastenings to which it was attached broke, and the chain had to be withdrawn. M. Tonneau's chains are said to be very suitable for cranes, crabs, inclined planes, and cages in mines.

WATER CONVERTED INTO FIRE.—There have been speculations as to the possibility of such a transformation for a long time. But in a recent number of the *Cosmos*—a scientific journal, of a high character, published in Paris—the Abbé Moigno, the editor, informs his readers that he has seen this at the workshop of the discoverer, M. Festud de Beauregard, in the Rue Lafayette, and that the action and the effects are truly admirable. It has long been known that when oxygen and hydrogen gases unite and form steam, as they do by their union, a most intense heat is produced. In this case, in fact, we have the oxhydrogen blowpipe, which though very small, is yet a furnace of the most intense heat. It is now found that by exposing steam in its turn to a very high temperature, the atom of oxygen and the atom of hydrogen—of both of which, in union with each other, an atom of steam consists—tend to seperate again, and in fact may be actually separated merely by presenting to the very hot steam some substance with which one of the elements of the steam, either the oxygen or the hydrogen, tends to unite rather than the other. But no sooner are the oxygen and the hydrogen separated than they tend to rush together again, producing in the act of union the heat of the oxyhydrogen blowpipe. In order to obtain this wonderful power of heat all that is necessary, as now appears, is to raise steam to a very high temperature, and then to let it loose when very hot upon some body which tends to unite with one of its elements: its oxygen for instance, as is the case with common fuel. The hot steam immediately sets the fuel on fire. M. Moigno mentions that in the apparatus which he saw, a jet of hot steam from a tube, which was only one millimetre (about 1-25th of an inch) in diameter, when made to play upon a mass of charcoal in a furnace, lighted it up into a most vivid fire. The only point that is staggering is the immense heat which requires to be imparted to the superheated steam. Thus, for the full effect, 1000 deg. cent. is named,—that is, 1832 deg. Fahr.—that is, a heat at which silver and almost copper melts. And this said to be produced by having the steam-heater immersed in a bath of melted tin. As there is no need of great pressure, however, and no risk of explosion (for no water at all is admitted to the steam-heater), it may be found possible both to command and to control steam at this temperature with economy upon the whole. And if so, there can be no doubt that not only in the laboratory of the chemist, but in the reducing of metals and in the arts generally, on a great scale, the application of superheated steam will form an epoch.

NEW FORTS AT SHEERNESS.—The Government are about to erect new forts at Cheney Rock and Queensborough with a view to the protection of the estuary of the Thames and the River Medway, in addition to which the already existing and formidable fortifications at Sheerness are being rendered still more formidable. For their better armament 15 100-pounder Armstrong guns have just been received. When the works now in progress are thoroughly completed and the guns fitted, the armament at Sheerness will be one of the most powerful coast defences of England.

WORKMEN EMPLOYED AT OUR DOCKYARDS.—From the Navy Estimates just issued we learn that at the present time there are 10,800 workmen employed at the dockyards at Deptford, Woolwich, Chatham, Sheerness, Portsmouth, Devonport, and Pembroke. The men are thus described:—Shipwrights and apprentices, 4000; caulkers and apprentices, 330; joiners, 609; sawyers, 330; smiths and apprentices, 877; workmen at millwrights' shops and apprentices, 249; workmen at block, saw, and metal mills, 241; riggers, 633; sailmakers and apprentices, 204; spinners and houseboys, 449; other trades, 652; labourers, 907; hired labourers (1st class), 1319. It is intended to reduce the number as vacancies occur to 9621, the number established by order in council of the 19th June, 1650.

PLYMOUTH NEW LIFEBOAT.—The new lifeboat, which Miss Burdett Coutts has, through the National Lifeboat Institution, presented to Plymouth, underwent a most satisfactory harbour trial in London on the 14th ult. The boat is 34 ft. long, 7 ft. wide, and rows 7 oars. Her self-righting qualities were fully and satisfactorily tested. The water she shipped was self-ejected through patent valves, in about fifteen seconds. The following are some of the qualities of this boat:—1. Great lateral stability. 2. Speed against a heavy sea. 3. Facility for launching and taking the shore. 4. Immediate self-discharge of any water breaking into her. 5. The important advantage of self-righting, if upset. 6. Strength. 7. Stowage room for a number of passengers. The boat was built by the Messrs. Forrest, of Limehouse.

TRAIN'S VICTORIA-STREET TRAMWAY.—At a recent meeting of the Board of Works of St. Margaret's and St. John's, an investigation was made into the various complaints made against the Victoria-street tramway and the numerous accidents said to have been caused by it. The meeting unanimously resolved to serve Mr. Train with a final notice for its removal as a dangerous nuisance, in pursuance of the agreement entered into to be enforced in case of its unsuccessful operation. The time allowed in the notice will expire by the middle of the month of March, and according to the agreement referred to, Mr. Train is compelled, under a penalty of £1,000, deposited by him in the hands of the treasurer of the board, to remove the rails and reinstate the road in its former condition, entirely at his own expense, within that period. It was also observed at the above meeting that a protracted contest took place on Mr. Train's original application to lay down the line, and that a great point was strained to grant him the concession as an experiment, from apprehensions of the results that have taken place. Since the operation of the tramway frequent applications had been made to extend it through Parliament-street, as far as the Horse-guards' entrance, that being the limit of jurisdiction of the board over that thoroughfare, but had been latterly met with a peremptory refusal, on the ground that the scheme was a failure in London.

PARAFFINE, OR COAL OILS.—Paraffine, or, as this fluid is frequently termed, coal oil, has been for some years past largely used as an illuminating agent. The cleanliness and the economy of the paraffine lamps, with the brilliancy of the light produced, have led to their very general adoption, especially in those places where the conveniences of gas have not as yet been made available. Paraffine, and indeed all the varieties of the oils which are sold under this name, are, like it, compounds of carbon and hydrogen. They are produced by the distillation, at carefully-regulated temperatures, of coal, of certain carbonacious shales, and the different varieties of petroleum, which are now so largely obtained in America and in Asia. As we have said, from whatever source derived, these oils are hydrocarbons, and, according to the temperature at which the distillation is effected, there result heavy or light oils, as they are termed by the manufacturers. These oils are of variable specific gravities, and their boiling points range all the way from 46° to 600° Fahr. Hence it is that explosions have arisen from the improper admixture of the lighter oils with the heavier ones. In some cases this has arisen from insufficient purification of the oil for burning, and in others (which include by far the larger number of cases) by the mixture of volatile oils obtained from other sources, with the less inflammable oils distilled from coal. In the early stages of this manufacture Cannel coal was almost exclusively used as the oil-yielding material, but since the discovery of the oil wells of Pennsylvania and other places, petroleum has in a great measure supplanted the use of coal, some establishments using the natural oil alone. The object of this is readily appreciated. The petroleum being naturally in a liquid state, there is no necessity for a preliminary distillation, as in the case when coal is used, in which event the crude oil must be first produced by exposing the coal to distillation at a low heat, and the resulting product be treated in the same manner as the oil already formed in the wells. By the use of petroleum the retorts for the first distillation are dispensed with, and thus a saving is effected in apparatus as well as in time and labour. When petroleum alone is used in the manufacture of kerosene oil the product contains a much larger proportion of volatile hydrocarbons than when coal is wholly or partially employed, and therefore more precautions are necessary and greater labour is requisite to effectually get rid of these dangerous substances. Some manufacturers not only neglect to remove the volatile compounds from the oils, but actually purchase the light oils from more conscientious refiners, in order to mix them with heavy oils to make them burn. This is an exceedingly reprehensible practice, and deserving severe punishment, for the heat generated by the heavy oils in burning vaporises the volatile portion, and renders it liable at any time to explode. The oils distilled wholly from coal, or those with which but a small proportion of petroleum has been mingled, are much more easily freed from dangerous portions. By a careful refining, and after distillation, steaming, and a large surface of atmospheric exposure, every dangerous compound can be removed, and no fear need be apprehended from oils which are known to be subjected to a rigid and conscientious refining. In purchasing oils, however, nothing should be taken for granted. They should be carefully tested, and their liability to explode fully investigated. The simplest and most satisfactory test of safety is to place the oil in an open dish in a water bath, and heat it up to 130° to 140° Fahr. If when elevated to this temperature, on applying a match it does not ignite, it may be pronounced very safe. If it ignites but slowly or sluggishly, it is safe. But any oil that lights quickly in an open dish, at temperatures below 130° Fahr., may be considered as dangerous. We have seen oil the vapour of which ignited with a smart puff or explosion at 60° Fahr., on holding a lighted match more than 1in. above its surface. This was dangerous in the highest degree, and the vendor of such a compound should be held to strict accountability for any accident occurring from its being burned in lamps. The extensive use of these oil lamps amongst the working classes ought to induce especial attention to this very simple test. To those who may not be provided with a thermometer to measure the temperature, the following simple rule may be adopted:—Pour into a basin a pint of boiling water, and allow it to stand to cool for five minutes; then pour some of the paraffine oil into a teaspoon, and having floated the bulb of the spoon on the hot water, leave it at rest a few minutes; then hold a lighted match a little above the spirit; if it ignites quickly it is dangerous, if not at all, or very slowly, the paraffine may be used without fear of accident. A metallic fountain or reservoir should always be avoided in using any of these hydrocarbon oils. To show the vast difference of the oils now on sale as paraffine oils in this country, Dr. R. Angus Smith, F.R.S., of Manchester, an eminent chemist, has lately found that oil made by Mr. Young, the inventor, and his partners, from coal, and who have really the only right to call their oil paraffine, will not ignite in an open vessel at 154° Fahr.; whilst a sample of American rock oil, sold as paraffine, exploded at a temperature of 46° Fahr.

PARAFFINE OR ROCK OIL IN SHROPSHIRE.—Mr. G. Shepherd, C.E., is of opinion we have an abundant supply of paraffine in England, which can be obtained at a cheap rate. In the Shropshire iron districts, he says there is a rock known to the miners as the "stinking rock;" this rock yields a great deal of mineral tar; it is found in sinking to the coal and ironstone, and it is many feet thick.

CEMENT FOR ROOMS.—A recent invention by M. Love is thus described. The invention consists in the discovery of a property possessed by oxychloride of zinc, which renders it superior to the plaster of Paris for coating the walls of rooms. It is applied in the following manner. A coat of oxide of zinc mixed with size, made up like a wash, is first laid on the wall, ceiling, or wainscot, and over that a coat of chloride of zinc applied, being prepared in the same way as the first wash. The oxide and chloride effect an immediate combination, and form a kind of cement smooth and polished as glass, and possessing the advantages of oil paint, without its disadvantages of smell, &c.

A MODEL OF A LIFEBOAT on a new principle has been exhibited at the Underwriter's Room, Liverpool. The boat is constructed without a bottom, a rope net being introduced to prevent persons from falling through, and there are two heavy iron keels, which act as ballast, and keep her steady in the water. The body of the boat is filled with air-tight barrels, and the fenders, gunwales, seats, mats, &c., are hollow, so that, if necessary, they may be thrown into the sea and turned to account as life-preservers. It is stated that under any circumstances the boat, which is the invention of Mr. J. M. Holbrook, will maintain an upright position.

ADULTERATION OF FOOD.—Dr. Letheby, the Medical Officer to the City Commission of Sewers, states in his quarterly report that no application has been made to him during the quarter for the analysis of food or drink, and he adds that "it is to be feared, from the experience of the last six months, that the Adulteration of Food Act will become a dead letter."

DEODORISING SEWERS.—In a report from Dr. Letheby and Mr. Hayward it is stated that charcoal has a property of absorbing foul gases, and a practical specimen of its efficacy has been made over a space of about fifty-seven acres in the east of London. The report says:—The total length of sewers in the district is 25,587ft., of which 2081ft. are pipes, and the remainder are constructed of brick varying from 3ft. high by 2ft. wide, to 5ft. high by 3ft. wide, internal dimensions. Upon this length of sewer there are 104 air shafts, 265 gullies, 15 flushing shafts, 4 tanks, and 26 side entrances. The deodorising power of the charcoal has been satisfactorily proved to be complete. Not only have there been no complaints from the public of stenches from the ventilating gratings, but we have ascertained by actual observation that the odour of the sewer gases is not perceptible when they have traversed the charcoal. The deodorising power of the charcoal endures for a great length of time, and the ventilators tried were in action from nine to twenty months. The report says that the power will last for years. As to cost it is remarked, "The expenditure incurred in fitting up the 104 ventilating shafts is £918 18s. 5d., which is at the rate of about £8 16s. 8d. per ventilator.

MR. JOHN WHITE, of the Medina dock, Cowes, Isle of Wight, has received an order from the Admiralty for the construction of twenty lifeboats, cutters, and gigs, their lordships having determined that every ship serving on the west coast of Africa shall in future be supplied with one of each description.

NAVAL ENGINEERING.

THE "DEFIANCE," 89, was taken from Hamoaze on the 5th ult., to Plymouth Sound, for the purpose of testing her machinery, constructed by Messrs. Maudslay and Co. The force of the wind was at four, and there was a considerable ground swell. The *Defiance* is a vessel of 3475 tons. Her draught is 18ft. 3in. forward, and 20ft. 4in. aft. Her engines (horizontal) are of 800 horse-power; the diameter of the screw, 19ft.; and pitch, 27ft. 6in. The measured mile was run six times with an average result of 11·930 knots. Steam was fairly maintained at full pressure, with a vacuum of 24½in.; average revolutions, 58·6. Two runs were afterwards made with half boiler power, when the result was 8·960 knots; revolutions, 45.

THE "GLASGOW," screw frigate, recently launched at Portsmouth, made her official trial of speed at Stokes Bay, on the 13th ult. The *Glasgow* is of 3038 tons, her engines being of 600 H.P., nominal, from the manufactory of Messrs. Ravenhill aud Co., working with a screw propeller. Six runs were made at the time, the mean of which gave the ship a speed in knots of 13·200, with the maximum number of revolutions at 60; pressure of steam 20lbs.; vacum, 25; draught of water forward, 17ft. 10in., and aft 19ft. 6in. The performance of the machinery was extremely satisfactory, there being no hot bearings or failure of any kind.

THE "ZEALOUS," 80 guns, screw line of battle ship, now in course of building at the Royal Dockyard at Pembroke, is to be treated in a similar manner as the *Triumph*, and altered to a 51 gun iron-cased frigate. The *Zealous* was intended to be of 800 H.P. and 3,716 tons burden, but her nominal power will doubtless be altered.

THE "CHANTICLEER," 17, screw, made her official trial of speed at load draught, at the measured mile in Stokes' Bay, on the 12th ult. The ship's draught of water was 14ft. forward, and 15ft. 2in. aft. Her propeller was a "Griffith," with a pitch of 15ft. and a diameter of 12ft. The vessel was tried first with full and afterwards two-thirds boiler power. The mean of her runs under the first-named conditions giving her a speed of 10 knots, and with the latter a speed of 9¼ knots. The machinery gave perfect satisfaction by its working during the trial, and the boilers maintained a plentiful supply of steam.

THE "GALATEA," 26. On the 8th ult. a trial of the engines and machinery of this screw steam frigate took place outside Plymouth Sound. This ship (sister to the *Ariadne*) of 3227 tons, is 280ft. long, and 49ft. broad. Her draught forward is 20ft. 9in., and aft 21ft. 9in. She is fitted with a pair of trunk engines of 800 horse-power, by Messrs. Penn and Co., and made six runs at the measured mile with an average of a fraction over 13 knots; revolutions, 57½; vacuum, 26 to 28; pressure of steam, 21lbs. There was no appearance of heat about the bearings, and the trial was considered to be very satisfactory.

THE "ROYAL OAK."—The armour-plates for this iron-cased frigate are to be bent cold, to effect which the most powerful hydraulic pressure will be required. The engines now erecting alongside the *Royal Oak* for this purpose being calculated to exert a force of 2000 tons to the square inch.

"THE EURYALUS," screw frigate, tested her speed at deep draught at the measured mile at Stokes Bay, on the 14th ult. The ship's draught of water was, forward, 20ft. 7in., and aft 22ft. 4in. Her screw was of the common Admiralty pattern, with the leading corners cut, with a diameter of 17ft., and a pitch of 21ft. The load on the safety valve was 20, the average revolutions 56, and the mean speed of the runs made, 9·469 knots. A complete circle was made under full steam in six minutes and two seconds. Her engines are of 400-horse power, nominal, by Messrs. Penn and Son, and their working was pronounced perfectly satisfactory.

THE SEGMENT of a ship's side, weighing 15 tons, and representing a portion of the broadside of the *Warrior*, built entirely of iron, has been received at Woolwich from Messrs. Fairbairn & Co., of Manchester, and has been forwarded to Shoeburyness, to test the power of resistance in competition with a target of equal depth and dimensions, backed by timber instead of iron, and faced with iron slabs. This experiment it is stated, is intended to decide the advantage of building ships exclusively of iron.

THE "WARRIOR," 40, iron frigate, is ordered to Portsmouth from Gibraltar. Her list of defects, sent home from Lisbon, is something formidable. It is also asserted that the statement of the ship's labouring heavily, and refusing to answer her helm on her outward voyage to Lisbon, was really less than the truth, although partially contradicted by Lord C. Paget in his answer to the question recently put in the House of Commons.

TESTING ARMOUR PLATES.—The testing of the armour plates from the works of the Thames Iron Ship Company, the Atlas, at Sheffield; and the Lancefield, at Glasgow; were brought to a conclusion on the 14th ult. The plates as usual were affixed to the sides of the *Java*, and the practice took place from the guns of the *Stork*, at 200 yards range. They were plates selected by the Government Inspector at each of the works from those manufactured in accordance with the right reserved by the Admiralty in their contract with the manufacturers. At this trial the "hammered plates" supplied by the Thames Iron Ship Building Company proved to be so superior that it will in all probability be the cause of the reopening of the question, "Hammered *v.* Rolled" armour plates. 100-pounder Armstrong guns were used for the trial. The order of merit was as follows: Thames, 1; Brown, Rigby and Beardmore, 3

THE "BAROSSA," 21, screw corvette, 1700 tons, 400 H.P., underwent a trial at the measured mile, Maplin Sands, on the 14th ult. The engines of the *Barossa* were constructed by Messrs. Bolton and Watt. The results of the trial were as follows:—Average speed, 12½ knots per hour; pressure of steam, 20lb.; vacuum, 25½; revolutions, 64; Griffith's screw, 24ft. pitch, 16ft. diameter; draught of water forward, 16ft. 6in.; aft, 19ft. The machinery worked easily and well, and the result was very satisfactory. Dr. Normanby's patent apparatus for distilling water with which the *Barossa* is fitted, was tested at the same time as the trial took place, and was attended with most satisfactory results, the water obtained by that process being quite as palateable and refreshing as the ordinary water on board.

THE NAVY ESTIMATES were introduced into the House of Commons on the 24th ult. The total charge for last year was £12,640,588, whereas it is this year only £11,794,305; showing a reduction of £846,283, the saving being mainly effected in the outlay upon naval stores. The substitution of iron-cased frigates for wooden line-of-battle ships, the former not requiring such heavy repairs, will, in future years, give opportunity for further retrenchment.

Our Iron-clad Navy.—In addition to the iron-cased vessels already launched, there are four others in the course of construction by contract, the building of which is estimated to cost £1,125,805. Of this sum, £120,000 have already been voted by the House of Commons, and the sum required for 1862-63, to further the completion of these four vessels, is £687,456.

Accident to the Iron-clad Steamer "Defence."—On the morning of the 22nd ult., a serious accident occurred to her Majesty's ship *Defence*, which ship was lying at Spithead. It appears that the *Hunter* gunboat left Portsmouth Harbour on the above morning, and steamed out to the *Defence*. There was a heavy swell running at the time, and it is asserted that as the *Hunter* went alongside, miscalculating her distance, she ran towards the bow of the ship, the bower-anchor of the latter just touching her side. As the swell lifted the gunboat, it caught the anchor, which broke away from the tumbler, and after being dragged away by the gunboat, rebounded against the bow of the ship, into the side of which the fluke completely picked a large hole. The iron at the bow is only five-eighths of an inch thick. It is stated that one of the pieces of iron knocked out has been examined, and found to be greatly deficient as regards the welding.

Naval Appointments.—The following naval appointments have taken place since our last:—J. A. Wilson, Engineer, to the *Indus*, for the *Lee*; T. E. Millar, Engineer, to the *Blenheim*, for the *Amelia*; J. Ross, Engineer, to the *Indus* as supernumerary; W. Ash, Engineer, to the *Hawke*, for the *Blazer*; G. Batchelor, Acting Engineer, to the *Blenheim*, for the *Britomart*; J. Bates, J. Clift, and A. Wood, First-class Assist. Engineers; D. Hughes, Acting First-class Assist. Engineer, and A. Forrest, Acting Second-class Engineer, to the *Blenheim*, for the *Escort*, *Raven*, *Charon*, *Clinker*, and *Julia*, gun vessels, respectively; J. G. Barron, J. T. Page, A. Watt, and A. Borthwick, First-class Assist. Engineers, to the *Hawke*, for the *Rose*, *Sandfly*, *Griper*, and *Highlander*, gun vessels, respectively; E. Pearce, Engineer, to the *Indus*, for the *Alert*; T. Huan, First-class Assist. Engineer, to the *Asia*, for the *Jasper*; J. Ross, Engineer, to the *Hawke*, for the *Lark*; D. Leitch, First-class Assist. Engineer; and G. R. Beer, Acting Second-class Engineer, to the *Hawke*, for the *Advice*; T. M. Thompson, Second-class Assist. Engineer, to the *Blenheim*, for the *Charon*; D. Hughes, First-class Assist. Engineer, to the *Indus*, for the *Clinker*; J. Boswell, Acting First-class Assist. Engineer, to the *Blenheim*, for the *Heron*; J. H. Trelwing, Chief Engineer, to the *Virago*, vice *M'Innes*, superseded, sick; H. W. Elgar, promoted to Chief Engineer, and discharged on half-pay; W. Fedach, Acting First-class Assist Engineer, from the *Asia* to the *Indus*, as supernumerary; W. H. Lowman, First-class Assist. Engineer, to the *Fisgard*, for the *Rapid*; P. Butler, First-class Assist. Engineer, from the *Asia*, to the *Cumberland*, as supernumerary; G. A. Patterson, J. R. Potam, F. M. C. Richard, and T. Vickery, Acting Second-class Assist. Engineers, to the *Asia*, as supernumeraries; R. W. Topp, confirmed as First-class Assist. Engineer, to the *Indus*; J. Bolus, confirmed as Second-class Assist. Engineer, in the *Nile*. H. Bunting, confirmed, as a Second-class Assist. Engineer, in the *Hero*; P. Wood, Chief Engineer, to the *Indus*, for the *Rattlesnake*; G. Elliott, Acting Second-class Assist. Engineer, to the *Indus*, for the *Magicienne*; J. Phillips, Second-class Assist. Engineer, confirmed, in the *Clio*; P. Butter, promoted to Engineer, supernumerary, in the *Cumberland*; W. W. Webber, confirmed as First-class Assist. Engineer, in the *Shannon*; D. Driscoll, First-class Assist. Engineer, to the *Asia*, for hospital treatment; H. Coller, confirmed, as Second-class Assist. Engineer, in the *Cornwallis*.

STEAM SHIPPING.

The "Peru," Pacific Steam Navigation Company's steamer, made the voyage out to St. Vincent, *en route* for the Pacific, in nine days and two hours, including a stoppage of six hours at Queenstown. Her consumption of coal was 264 tons, or 24 cwt. per hour, for an indicated power of 1,200 horses, or about 2¼lbs. per indicated horse power.

New Steamer for the North German Lloyd's New York Line.—Messrs. Caird and Co. have contracted with the North German Lloyd's to build a screw steamer of 2540 tons to trade between the ports of Bremen, Southampton, and New York, as a consort to the *Hansa*.

The South Eastern Railway Company in anticipation of increased passenger traffic during the Exhibition, have given orders for a sister vessel to the steamer Victoria, which was put on the Folkestone and Boulogne station last season, and has proved herself a remarkably fast boat. The new boat is to be built by Messrs. Samuda Brothers, and the engines by Messrs. Penn & Son.

The "Ville de Brest," an exquisitely modelled iron steamer, was launched on the 11th ult., from the building yard of Mr. Laing, Deptford on the Wear. Her dimensions are as follows:—Length, 200ft.; breadth, 27ft.; depth, 18ft. 7in.; classes nine years, and is 630 tons.

Accident from the Screw of the Great Eastern.—On the afternoon of the 16th ult., while the *Great Eastern* steamer was being placed on the gridiron at Milford, a boat belonging to her Majesty's ship *Blenheim* got entangled with the screw just at the time it was set in motion, and was cut in two. One man was killed, and several others were severely injured. There were 22 men in the boat at the time of the accident.

The Paddle-wheel Steamer "Reiver."—The hull and machinery were designed and constructed by Messrs. John Laird, Sons, and Co., and are most substantially built and equipped in every way for hard seagoing work. The following are the principal dimensions of the vessel and machinery:—Vessel: Length between perpendiculars, 302ft.; extreme length, 315ft. 9in.; width between paddles, 31ft.; extreme width, 60ft.; depth in hold, 17ft. 8in.; builders' measurement, 1448$\frac{61}{94}$ tons; gross register, 1189$\frac{33}{100}$ tons. Machinery: Diagonal engines, 412 H.P.; diameter of cylinder, 74in.; length of stroke, 6ft. 6in.; diameter of wheel (feathering) to outside of float, 29ft.; diameter to axis of float, 25ft.; number of floats on each wheel, 12. The boilers are fitted with apparatus for superheating the steam and heating the feed water. The cylinders have steam jackets, and they and the exposed parts of the boilers are lagged. There is a complete arrangement of surface condensers, in addition to the ordinary jet condenser, either of which can be worked at pleasure. In December several trials were made with about 100 tons weight on board, or in what may be considered light trim, and a speed of more than 16 knots was obtained, the engines making 24 revolutions per minute. It was found that the same result was obtained with the surface condenser as with the ordinary jet condenser. During January a series of trials were made to test the consumption of coal at various rates of speed, the vessel being loaded with about 450 tons dead weight. The following results were obtained with the ordinary condensers:—A speed of 12 knots with 28 tons 12 cwt. per day, or 2½lbs. per indicated horse power per hour; 14 knots, with 51 tons per day, 2¾lbs. per hour; 15 knots, with 70 tons 6 cwt. per day, 3lbs. per hour; and with the surface condenser a speed of 15 knots, with 66 tons 8 cwt. per day, or 2$\frac{8}{10}$lbs. per indicated horse-power per hour. The coal used was Powell's Duffryn steam coal, which was taken direct from the bunkers, and not picked. The weather, during all these trials, was unfavourable. When the size of the vessel, the weight on board, and the speed are taken into account, these performances must be considered most satisfactory. The *Reiver* is for Messrs. Jardine, Matheson, and Co., and is intended to trade in Chinese waters.

The "China."—This new Clyde-built screw steamer arrived in Liverpool on the 6th ult., from which port she will sail with the American mails to-day. This fine vessel made the run from the Clock Lighthouse, near Greenock, to the Bell Buoy at the mouth of the Mersey, in 12 hours and 26 minutes, with a 12lb. pressure of steam. This is equal to 14 nautical or 16·1 statute miles per hour all the way through, the distance being about 203 statute miles. The *China* is a large and powerful iron steamer, as may be gathered from the following details of her dimensions and power. In length she measures 326ft. between perpendiculars, or about 355ft. over all. She is 40ft. 6in. in moulded breadth; and 27ft. 6in. in depth to the upper deck. Her gross tonnage is 2529 and her registered tonnage 1539 tons, allowing 989·40 tons for propelling power. She is propelled by two beautifully constructed engines on the oscillating principle, with 550 collective horse-power.

The "Lord Clyde," paddle steamer, has been contracted for by Messrs. Caird and Co., of Greenock. She is intended for the Glasgow and Dublin Steam Packet Company. Her dimensions are as follows: 230ft. long, 26ft. broad, with engines of 300 H.P.

LAUNCHES OF STEAMERS.

Launch of the "Leith."—Messrs. S. and H. Morton and Co., on the 30th January, launched from their yard at Leith, a large iron steamship, destined to trade between Leith and St. Petersburgh in concert with the steamers *Stirling* and *Czar* already on the station. The *Leith* measures 260ft. in length, 30ft. in breadth inside, and 25ft. in depth of hold. She is about 1300 tons register, and is the largest vessel belonging to the port of Leith, or running from any port to the Baltic. She is classed twelve years A1 at Lloyd's, the highest class awarded to iron ships, and has been built in excess of the strength required by Lloyd's rules. Her main deck is iron, and she has a spar-deck from end to end. Her cabin will be in the middle of the ship, or centre of motion, for the benefit of passengers liable to sea-sickness. She is divided into eight water-tight compartments, and will have every modern appliance. Her engines are of 200 H.P., on the double-cylinder principle, patented by Mr. Marshall, of the firm of Messrs. S. and H. Morton and Co.

"The Caledonia," screw steamer, was lately launched from the building yard of Messrs. Tod and McGregor. This vessel is intended to take the place of the *United States*, lately lost, and which had been built by the same firm for the Anchor line. She will consequently be employed in the Montreal and New York trade. The dimensions of the Caledonia are as follows:—Length of keel and forerake, 252ft.; breadth ditto moulded beam 33ft.; moulded depth 22ft. 9in.; tonnage (old measurement), 1360. She is to be propelled by a pair of direct acting engines of 135-horse power, nominal.

RAILWAYS.

London and North-Western.—The capital account of this company, on the 31st December last, shows that £24,650,765 had been received on stock and shares, £10,349,283 on debentures, £312,830 on 3½ per cent. debenture stock, and £1,446,788 on 4 per cent.; total, £36,759,666. The expenditure on capital account shows that £25,764,908 had been expended on the main line, stations, and works, including legal and other charges; £3,730,150 on working stock; £461,068 on lands and buildings yielding rent; and £6,452,906 on lines in which the company have an interest, making the total expenditure £36,409,031, and leaving a balance of £350,634. The working stock of the company consists of 972 locomotive engines, 966 tenders, 783 first-class mails, and composite carriages, 713 second-class carriages, 476 third-class carriages, 48 travelling post-offices and tenders, 378 horse-boxes, 273 carriage trucks, 349 guards', break, and parcel vans, 36 parcel carts, trucks, &c., 14,856 goods waggons, 1,418 cattle waggons, 284 sheep vans, 1,619 coke waggons, 195 carts, 14,393 sheets, and 426 horses.

The Shrewsbury and Welchpool Railway was opened throughout on the 2nd ult. At present it is a single line, but application is to be made to Parliament for powers to lay a double line of rails.

The Eastern Counties Railway Company is about to proceed with the line (for which it obtained Parliamentary powers last session) between Bury St. Edmonds and Sudbury.

Railway Extension to Charing Cross.—The whole of the materials composing the range of shops known as the South-eastern arcade, London-bridge railway station, were sold by auction on the 9th ult., the site being required for the new railway extension to Charing-cross.

The Severn Valley Railway, extending from the West Midland at Hartlebury, to Shrewsbury, a distance of about forty miles, has been opened. The line has been constructed on the narrow guage, and is a single line throughout, though the bridges and viaducts are built for a double line. The gradients are generally good, but there are some sharp curves on the line, occasioned by its following the course of the Severn, for a considerable distance. It enters the valley of the Severn at Bewdley, and crosses the river by an iron bridge of one arch 200ft. span. The line continues on the west side of the river, until it runs into the Shrewsbury and Hereford Railway, about a mile from Shrewsbury. The line is worked by the West Midland Company.

The Railway Carriages, recently built at the Eastern Counties workshops are among the most commodious and comfortable in the kingdom. They are of somewhat unusual weight, the first-class on four wooden wheels 3ft. 6in. in diameter, and seating eighteen passengers in their compartments, weighing, empty, 6 tons, 12½ cwt. The bodies of these carriages are 21ft. long. The second-class carriages also have four wheels, are 21ft. long, and weigh 6 tons 7¾ cwt.

The Eastern Counties Railway Company are having plans prepared for a number of new express engines to weigh 30 tons each, and to have 16in. cylinders, 24in. stroke, and 7ft. driving wheels.

The Turin and Savona Railway.—A prospectus has been issued of a new Italian line to be called as above, with a capital of £2,408,000, including £368,000 for a branch to Aqui. Of this sum £480,000 will be a subvention or free gift from the Government, and communes, £800,000 in shares, and the remainder in obligations, of which £368,000, the sum required for the Aqui branch, is to enjoy a Government guarantee. The distance from Turin to the port of Savona is 90 miles, and the branch to Aqui will be 30 miles, making a total length of 120 miles.

The Bristol Port Railway and Pier Company has issued a prospectus, with a capital of £125,000 in shares of £10. The object is to obviate the delay and inconvenience of the present water transit from the mouth of the Avon to the city and docks of Bristol. The line, which will be 5¾ miles through an attractive district for building purposes, has been strongly recommended by leading engineers as an essential work for the prosperity of the port.

Somerset and Dorset Central.—The opening for public traffic of these companies' lines, between Glastonbury and the London and South Western Railway, at Temple Coombe, took place on the 3rd ult. Passengers are now booked through from Burnham Highbridge to the Waterloo Station, and also to Salisbury, Bishopstoke, Southampton, Portsmouth, &c., and *vice versa*. A fast steamer runs between Cardiff and Burnham.

Submarine Railway between France and England.—The scheme proposed by Mr. J. Chalmers for uniting the English and French railways by means of a submarine railway has been submitted to the directors of some of the principal railway companies in England, with a view to the appointment of a committee of railway men to inquire into the whole scheme, and to report thereon as to its practicability and utility. He proposed to cross the English Channel by a submarine railway, enclosed in iron tubes, extending from a point about two miles to the east of Dover to a point on the French coast about seven miles to the west of Calais, the line being about 20 miles in length. The depth of water in the central portion of the Channel is about 168 ft., gradually diminishing towards the English and French shores. It is proposed to construct a double line of railway through a continuous series of wrought-iron tubes, each 400ft. in length and 30ft. in diameter, braced and strengthned in a peculiar way, having water-tight joints. The wrought-iron tube, when completed, is intended to pass along the bottom of the Channel, the shore ends of it being carried for some distance under the beach, and continued inland by means of tunnels having rising gradients to meet the level of railways in England and France. It is stated that the gradients would not exceed 11ft. per mile, which would practically be as good as level. A large ventilating shaft and lighthouse constructed of iron and stone is proposed to be fixed in the centre of the Channel through which the main tube is intended to pass; other ventilators near the shore ends would be erected if necessary, and be provided with lighthouse apparatus. Mr. Chalmers propose that the laying of the tubes shall commence in both directions from the large ventilating shaft in mid-channel, and by means of certain appliances to perform the difficult operation of fixing the tubes in their proper positions and connecting them together. Wrought-iron boxes or collars filled with stones on each side of the tubes are intended to keep them down on the bottom of the Channel; in addition to which a quantity of stones or chalk is to be thrown from vessels over the tubes, so as to form a kind of ridge across the bottom of the Channel about 40 feet in height and 140 feet wide at the base, enclosing the tube and leaving the depth at low water over it to range from 40 feet to 120 feet. Mr. Chalmers appears to have given a great deal of consideration to the subject, is confident of the practicabililty of completing the undertaking in three years, and taking passengers from London to Paris without change of carriage in seven or eight hours. He estimates the total cost, including four miles of tunnel approaches, at £12,000,000, or £500,000 per mile, for a double line of railway; that the traffic or toll, would yield £1,300,000 a year, or 10 per cent. on the outlay, being about £52,000 per mile per annum, or about £1,000 per mile per week.

RAILWAY ACCIDENTS.

COLLISION ON THE LONDON AND NORTH-WESTERN RAILWAY.—On the 3rd ult. an accident which proved fatal to one individual occurred near Wolverton station, on the above line of railway, through a collision. It appears that a cattle train left Crewe at the usual hour to proceed to the London station of the North London Railway, viz., the cattle station in York-road, King's-cross. The train, which was heavily laden with cattle, after it left Crewe proceeded at a steady pace until near the Wolverton station, when the parties in charge heard a train approaching at a rapid pace. This turned out to be a coal train, but before it could be brought up a collision took place.

FALLING OF A BRIDGE ON THE DORSET CENTRAL RAILWAY.—An accident lately occurred at Pitcomb, on this line, the arch over the turnpike road suddenly giving way. A large portion of the lower ring of brickwork fell into the road. An engine from Templecombe was approaching at the moment; and before the signal to stop could be made, the engine, most fortunately, passed safely over the remains of the bridge. It has now been determined to put a flat iron top to the bridge.

RAILWAY ACCIDENTS.—In the House of Commons, on the 13th ult., the President of the Board of Trade was asked whether in consequence of the repeated recurrence of railway accidents, it was the intention of Her Majesty's Government to improve, during the present session, any measure founded on the report of the Committee on Railway Accidents, which was laid upon the table of the House in 1858. To this question Mr. M. Gibson replied that it did not appear from the reports which had been made by the inspectors on recent railway accidents to the Board of Trade, that any new circumstances had arisen during the past year to render desirable the interference of Government in the management of railways. Therefore it was not the intention of the Government to introduce any bill on the subject. Although two lamentable accidents occurred during the past year, in which a number of lives were lost, and persons injured, the total number of accidents during 1860-61 was less than in any year, except 1857 and 1858, since 1851, notwithstanding that the total miles over which traffic was conveyed had increased by 50 per cent., and the total number of passengers 100 per cent.

TELEGRAPHIC ENGINEERING.

MEDITERRANEAN EXTENSION TELEGRAPH COMPANY.—At a meeting of this company on the 7th ult., a report was presented stating that the messages in the past half year have more than doubled, while no material increase has taken place in the expenditure. Arrangements have been completed with the Italian Government by which a systematic transmission of communication through Italy may be secured. The attempt to restore the old submarine cables has failed, but the new lines between Malta, Sicily, Corfu, and Otranto, are working efficiently. The Italian Government are about to lay a submarine cable between Sicily and Sardinia, by which means a more regular and speedy communication than by the Naples route will be obtained.

THE ELECTRIC AND INTERNATIONAL TELEGRAPH COMPANY have announced that they are about to lay a cable between Wales and the South Coast of Ireland. This cable will compete with the London and South of Ireland Direct Company's proposed line.

BRIDGES.

THE INTENDED NEW BRIDGE AT BLACKFRIARS.—The following designs were submitted to the Bridge-house Committee for selection, from which, as will be seen below, the design of Mr. Page was selected:—Sir John Rennie, a granite bridge of three arches, the centre span being 236ft. 10in.; Mr. George Rennie, five arches, centre span 150ft.; Mr. G. Rennie, five arches, each having a span of 125ft.; Mr. Mylne, five arches, centre span 156ft. The designs for a wrought-iron arched bridge were submitted by Mr. John Fowler, three arches, centre span 275ft.; Mr. John Fowler, five arches, centre span 184ft.; Mr. John Hawkshaw, three arches, spans 200ft. each; Mr. John Hawkshaw, five arches, spans 145ft. each; Mr. P. W. Barlow, three arches, centre span, 250ft. The design for a wrought iron girder bridge was submitted by Mr. R. P. Brereton, five openings, the centre opening being 220ft. The designs for a cast-iron arched bridge were submitted by Mr. Thomas Page, three arches, centre span 280ft.; Mr. Thomas Page, five arches, centre span of 156ft.; Messrs. George P. Bidder and Edwin Clark, five arches, each span being 172ft.; Mr. George Rennie, five arches, centre span of 160ft.; Mr. George Rennie, five arches, centre span of 175ft.; Mr. George Rennie, five arches, centre span of 180ft.; Mr. Robert William Mylne, five arches, centre span of 163ft. 6in.; Mr. Joseph Cubitt, five arches, centre span of 150ft.; Mr. James Brunlees, five arches, centre span of 172ft. The design selected was Mr. Page's, which was one of the handsomest and one of the cheapest. It was to consist of only three arches, the centre one being of the gigantic span of 280ft., or 40ft. wider than the central arch of Southwark Bridge. From the springing of the arch to the crown the rise is only 20ft., which, in a span of such an extent, merely amounts to the most gentle curve; so that, when seen from the river, the line of the structure would appear almost straight. The cornice beneath the parapet is of exceedingly bold and handsome design, surmounted with a parapet above of solid granite. The spandrils of the outer iron ribs on each side were closed, but filled up with figures in *bas relief* and ornamental scrollwork. The piers were designed to form the most massive and noble-looking features of the whole. There were to be four of these—two at the shore-side arches, and two in the river for the support of the centre arch. Each was to be of granite, of immense size, width, and depth, surmounted with a red granite Doric column, 40ft. high, 23ft. in diameter at base and capital, and 18ft. diameter in the column. Each, though built hollow, would weigh upwards of 500 tons. Their capitals reached to the summit of the bridge, and Mr. Page proposed to subsequently adorn them with colossal groups of statuary. The length of the bridge was to be the same as the present, but its width nearly double—namely, 76ft. against 42. There were to be two roadways of 14ft. wide, instead of, as now, two of 7ft. There were to be two tramways of 8½ft. wide. These were to be placed in the centre of the roadway, leaving two roads, each 16ft. wide, for the omnibuses and light traffic coming and going. The whole area of road and footway was to be 78,000ft., instead of 41,000, the area of the present structure. The cost of the old bridge was at the rate of £3 15*s.* 6*d.* per square foot of surface, while the cost of the new bridge, estimated at £245,000, is at the rate of £3 6*s.* a foot, or, size for size, nearly half the price of the old one.

THE LAMBETH BRIDGE.—The report of the directors of this company states that the whole of the land required for the works is in the hands of the contractors, and that it has become necessary to purchase more land than has been actually required for the site of the bridge; but this will become of value when the bridge is opened, and may be resold with advantage. The directors have arranged with the London Gas Light Company to lay down two mains of 18in. diameter, which has required an increase in the strength of of the structure, for which the company receives payment of £3000, with the advantage of the bridge being lighted free of cost. The Engineer's report states, that the cylinders of the Lambeth pier are completed to the level of high water, and have each been tested with 400 tons of iron. The cylinders of the Westminster pier are in process of sinking, and are nearly ready for testing. The experience of these operations confirms the undeniable economy and safety of the system of cylinder foundation. The abutments on both sides of the river are progressing rapidly. Messrs. Newall expect that the cables will be completed this month.

THE TEMPLE BRIDGE COMPANY.—The prospectus of this company, proposing to erect a suspension bridge of three spans of 300ft. each across the Thames between Essex-street, Strand, and Princes-street, Upper Stamford-street, Borough has appeared. The capital is to be £70,000, with borrowing power for £20,000. The contractors of the Lambeth Bridge are prepared to contract for the erection of the Temple Bridge for £45,000, taking one third in shares.

GAS SUPPLY.

THE WORCESTER GAS COMPANY have declared a dividend of 7 per cent. per annum. The Newcastle Gas Company a dividend for the half year of 6½ per cent. per annum, and the Collingham Gas Light and Coke Company a dividend of 6 per cent.

THE GLOUCESTER GAS COMPANY have lately extended their premises, and are now engaged in the erection of a gas holder, 80ft. in width, 50ft. deep, and capable of storing 250,000 cubic feet of gas—nearly double the quantity contained in the holders at present in use. The new holder will be suspended from six iron columns, each weighing 6½ tons, and 56ft. in height. These columns are braced together at the top by girders 5ft. in height and weighing five tons each. The depth of the tank under the holder is about 25ft.

WATER SUPPLY.

THE ARTESIAN WELL in connection with the new tank at Colchester is now being pushed rapidly forward, the borings having reached a depth of full 200 feet.

BOILER EXPLOSIONS.

THE ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.—At the last ordinary monthly meeting of the Executive Committee of this Association, held at the offices, 41, Corporation-street, Manchester, on Tuesday, January 28, 1862, William Fairbairn, Esq., C.E., F.R.S., in the chair, Mr. L. E. Fletcher, Chief Engineer, presented his monthly report, of which the following is an abstract:—"During the past month the ordinary visits of inspection have been made, and the following defects discovered in the boilers examined:—Fracture, 3 (1 dangerous); corrosion, 17 (2 dangerous); safety-valves out of order, 5 (1 dangerous); water guages ditto, 12 (1 dangerous); pressure guages ditto, 13; feed apparatus ditto, 5 (1 dangerous); blow-off cocks ditto, 22 (1 dangerous); fusible plugs ditto, 7; furnaces out of shape, 6 (1 dangerous); total, 90 (8 dangerous). Boilers without glass water guages, 2; without pressure guages, 1; without blow-off cocks, 6; without feed back pressure valves, 16. From the nature of the defects discovered during the last month, I would wish to take this opportunity of calling the attention of the members to the subject of corrosion, which is often stealthily eating away the strength of boilers entirely unsuspected; and I wish especially to put our members on their guard on this point, because I find that frequently when a boiler is discovered to be in a corroded state, even though it may have arrived at an advanced stage, and be on the point of rupture, still the discovery proves quite a matter of surprise to the owner, who expresses astonishment that his boiler should have been so affected. The fact is, however, that no boiler allowed to pass a whole year without being examined 'thoroughly' (*i.e.*, both inside and outside), so that the condition of all the plates may be ascertained on both their surfaces, can be pronounced as free from corrosion, or worked without risk—more in some cases, of course, than in others—in illustration of which I may state the following:—An ordinary internally fired boiler had been thoroughly overhauled, re-seated, and left in good repair two years ago, the Association not being afforded the opportunity of making the regular annual 'thorough' examinations during that time. This boiler was set on a mid-feather, and on being scaled a few days since, a hammer was sent through the plate at the bottom, which, on examination, proved to have been so eaten away as to have become at that part as thin as a sheet of paper. On going up the flues, I found that the plates were affected not at one place only, but throughout the whole length bearing on the mid-feather, and on removing some of the bricks, the plate was seen to be quite crumbling away, and at least a quarter of a pint of oxide was readily collected from a small surface only. In one or two places, where there had been small leaks at the ring seams (which so commonly happen when the feed without being previously heated enters the boiler immediately at the bottom), the mid-feather had ponded the water and held it in contact with the plates, in which it had cut complete channels, as well as eaten away surfaces of considerable area, while internally the plates were quite 'hogged' in places over the mid-feather, and the boiler was evidently in a most unsafe condition, so that a thorough repair (now in progress) was necessary. The danger of setting boilers on mid-feathers has for years past been pointed out by this Association, and the practice, I trust, will soon be entirely discarded. Explosions caused by mid-feathers are likely to be of the most destructive character, since the rent would not confine itself to a single plate, but extend throughout the whole of the weakened part, and nothing 'skies' a boiler more effectually than a longitudinal rent at the bottom. "I should add that it is by no means intended that the services rendered by this Association should diminish the exertions of the steam users' own engine attendants; but on the contrary, that it should stimulate them to greater care. Thus the fact of our inspectors getting inside each boiler annually, as well as going up the flues to make 'thorough' examinations, should by no means stand in the place of this being done by the owners' own engineers at least twice a year in addition. To leave the detection of corrosion to the sweeps who clean the flues, although sometimes allowed to be the case, is, I think, what no engineer would do, either having his master's interest at heart, or regarding his own safety as he should. Three explosions have occurred during the last month to boilers not under the inspection of this Association, each of which has been attended with fatal consequences; in one case as many as four men being killed, and several others wounded. One of these explosions happened to the boiler of a portable agricultural engine; another to a bath or kitchen boiler, in which the taps in the inlet and outlet pipes were both foolishly closed at the same time, so that, there being no safety-valve, the pressure was bottled up, as in the case of the *Great Eastern* water heater, and explosion became inevitable. A third explosion occurred to a colliery boiler, of plain cylindrical egg-ended construction, 40ft. in length, 5ft. 3in. in diameter, the plates being ⅜ths of an inch in thickness, and the working pressure 30lbs. per square inch. The boiler was fitted with two sufficient safety valves, and two floats, one of which had a low water alarm whistle; the explosion was occasioned by the plates over the furnace becoming overheated (although there was no evidence of deficiency of water), the boiler being rent into four pieces, each of which was blown a considerable distance. The cause of the overheating was attributed to the sedimentary character of the water, and I call the attention of our members to this fact as another illustration of what has been previously stated, that 'Incrustation should not be regarded merely as a matter of inconvenience, but frequently of positive danger.' There are other points of interest connected with this explosion, the consideration of which space compels me to defer to another opportunity."

Boiler Explosion.—A boiler explosion took place at the Fenton Park Furnaces, Fenton, Staffordshire (belonging to Messrs. Lawton & Co.), on the 21st ult. At these works there are two blast furnaces, worked by an engine which is supplied with four boilers. Only one of the furnaces was in work on this occasion, and one of the four boilers was out. The engine-tenter, having finished his night's work, reported to the furnace manager that all was right, then returned to the engine-house, and as he was leaving the building an explosion of three boilers took place; the engine-house was thrown down instantly, and the man was at once killed, buried beneath the ruins. The explosion not only shattered the engine-house to pieces, but demolished one of the furnaces, and every building in the vicinity was injured by the shock, as well as by the fragments of iron and the bricks, which were thrown with tremendous force a great distance.

ACCIDENTS TO MINES, MACHINERY, &c.

Colliery Explosion at Merthyr Tydvil.—On the 19th ult. an explosion, attended with the loss of fifty lives, took place at the Gethin Coal-pit, Merthyr Tydvil. This pit, the property of Mr. Crawshay, is within a short distance of the Taff Vale Railway, the workings being of the most extensive description, and has always been considered one of the most carefully worked pits in Wales, every precaution having been adopted to prevent the possibility of such a catastrophe as the above.

Flooding of Gosforth Colliery.—A flow of water has broken out in the shaft of Gosforth Colliery, near Newcastle, which has flooded the mine, and entirely suspended the workings, thus throwing out of employment 250 men and boys, most of whom, how ever, have since obtained work at other collieries. The flooding of the pit is believed to arise from the waters of the disused Heaton Colliery. The accident occurred while the men were drifting a staple from one seam to the other, through a "fault" in the limestone strata.

Accident in a Lead Mine.—On the morning of the 11th ult., the waters in the disused Hendre mines, near Mold, Flintshire, broke into the adjoining Bryn Gwiog lead lead mines, and drowned sixteen miners, only one of the whole number in the pit making his escape. The mines are near the high road connecting Mold and Denbigh, and four miles from the former town. The old Hendre mines, which were formerly very productive, had not been worked for some years; and as the country is hilly, and there are many streams in the neighbourhood, these mines have been filled with water for a long time. About twoyears ago a new company was formed, called the Bryn Gwiog Company, for the purpose of working the same bed of lead ore higher up the mountain than the Hendre mines. On Tuesday morning 17 men descended the mine, and after working for some time, they penetrated the wall dividing the new workings from the Hendre levels. The water rushed through the aperture, and the men had no chance of escape. Only one man being with extreme difficulty saved.

Colliery Accident.—At a short distance beyond Two Mile Hill is an old coal mine, the property of Mr. Whittuck and others, and known amongst the miners employed in it as "Tom Joy's" Pit. About half-past seven on the evening of the 13th ult., five or six men were at work, about 150 yards from the bottom of the shaft, in propping up with timber a portion of the roof of one of the drivings. Whilst they were thus occupied a "shot" was fired for the purpose of removing coal in another part of the driving, and from the shock caused thereby an immense mass of coal suddenly fell. It appears that the men had worked into an old "tip"—or shaft that had been rendered useless and filled up for many years, and the existence of which was unknown to the men engaged there—and come upon the old workings of the mine. One man happened, at the time of the fall, to be in the "tip," and the *débris* crushed him to death. Another man was a short distance in one of the old drivings, and on the coal falling he was instantly deprived of all means of communication with the shaft. As soon as the accident occured, the men in the pit commenced operations with a view to extricate the body of the deceased, and relieve the entombed man from his perilous position, but as several coal slips took place, it was of no avail.

The Hartley Colliery Accident.—The inquest on the bodies of the men and boys, killed by the late accident, terminated on the 6th ult., when the jury returned the following verdict :—"That John Gallagher, on the 22nd January last, was found killed in the workings of New Hartley Colliery, having died therein from inhalation of gas, being shut up in the yard seam of the said colliery, on the 16th of the said month, when the shaft was closed by the accidental breaking of the engine beam, which, with other materials, fell into the working shaft of the pit, and there being no exit therefrom, all access to the deceased was cut off, and he perished abovementioned. The jury cannot close without expressing their strong opinion of the imperative necessity of all working collieries having at least a second shaft or outlet to afford the workmen the means of escape should any obstruction take place as occurred at New Hartley Pit, and that in future the beams of colliery engines should be made of malleable instead of cast metal."

Accidents in Coal Mines.—A parliamentary paper has just been published, comprising an abstract of a return of the number of fatal accidents which have occurred in the coal mines in the United Kingdom since the system of colliery inspection came into operation. From this document we learn that the total number of tons of coal raised in the last ten years was 605,154,940; the total number of lives lost in the same period, 8,466; the average tons of coal raised to each life lost, 71,480; and the average of lives lost to one inspector, taking the present number (12), 705½.

Accident at Monkwearmouth Colliery.—On the night of the 9th ult., an accident occurred by the bursting of a feeder in the upcast shaft of the A or deep pit at Monkwearmouth Colliery. This colliery, as is generally known, has two shafts, the one a few yards from the other. The shaft of the A pit is nearly 300 fathoms deep; and that of the B pit 180 fathoms deep; and between the two shafts there is a communication by a drift, the workings being further connected by a bank about a mile distant, somewhere beneath Bishopwearmouth Church. The A pit has a 12 feet shaft, which is divided by a brattice into a down-cast or up-cast shaft, the B pit being also a down-cast shaft. The shaft of the A pit when sunk, about thirty-five years ago, was lined throughout with metal tubbing, which consists of segments of a circle, each measuring about four feet and a half in length, and one foot in breadth. About thirty fathoms from the pit mouth, in the up-cast shaft, one of these segments broke; and immediately a large feeder of water came away, at once extinguishing the furnace in the Maudlin seam, about forty yards from the bottom of the shaft, and by its fall reversing the system of the ventilation in the mine by carrying an immense volume of air down this shaft, which was converted into a down-cast, and the other shafts into up-cast shafts. The change was immediately felt in the pit, where the trap-doors refused to retain their accustomed position, and the men at work immediately fled to the shaft, and were speedily brought to bank.

MINES METALLURGY. &c

New Coal Field in Scotland.—The celebrated "Dunfermline splint" seam of coal has just been discovered in a new pit lately sunk on the estate of Lassodies. The coal is of unusually fine quality; and as the mineral field is extensive, and contains all the other seams of the district besides, the mineral wealth and the railway traffic of the locality will be greatly increased for many years to come. The coal field is opened up by the West of Fife and Edinburgh, Perth, and Dundee Railways, and Charlestown will be the principal shipping port.

Mining in Venezuela.—Accounts have been received by the mail of extraordinary discoveries of copper ore in the Aroa Valley : 400 tons of rich ore, averaging 35 per cent., have already been raised. The only means of conveyance to the coast, a distance of 60 miles, is by means of mules, a very expensive mode : but a company is about to be formed to purchase the land from the mines to the coast, which will not only double the value of the land passed through, but will enable the proprietors to realise a princely fortune, as the quantity of rich copper ore is said to be inexhaustible, and thousands of tons can be returned the first year without difficulty.

Transparency of Gold.—In describing the transparency of gold in very thin layers' Mr. Makins in his recent work, gives the following illustration :—"This transparency,', he says, "may be elegantly demonstrated, by taking some twenty grains of fine gold, and fusing it in a covenient shallow vessel; this is to be removed from the furnace in a completely fluid state, when, if watched, it will be observed that just upon cooling a crust of solid metal will first suddenly form, through which the light of the internal red-hot mass appears of a beautiful brilliant green colour."

Calcining Sulphur Ores.—Some improvements in furnaces for calcining sulphur ores, which are likely to become of importance in the manufacture of sulphuric acid, as they are said to offer a complete solution of the nuisance difficulty in the Swansea copper works, with the production annually of some £300,000 to £350,000 worth of sulphuric acid, at a merely nominal cost, have been invented by Mr. Peter Spence, of Pendleton Alum Works, Manchester. The inventor has already five furnaces at work in his own business, and four licences just commencing. Taking Dr. Percy's data as his guide, he declares that he could undertake to calcine all copper ores with about half of the present expenditure of fuel, and with the conversion of all the sulphur eliminated into sulphuric acid, the only cost of this acid being the nitrate of soda, which, with his furnace, is only half of that regularly used ; and, in addition to the interest of the capital invested in vitriol chambers, no labour would be expended on the acid manufacture.

New Substitute for Silver.—An improved combination of metals for the production of a white alloy, resisting the action of vegetable acids, has been provisionally specified by Mr. B. F. Trabuc, of Nimes. The alloy is formed by the combination of Banca tin, 875 parts; nickel, 55 parts; regulus of antimony, 50 parts; and bismuth, 20 parts = 1000 parts. A portion, say one-third of the tin, is placed in the bottom of the crucible, of suitable dimensions with the nickel, antimony, and bismuth; over this is placed a second third of the tin, and the whole is covered in by a layer of crushed wood charcoal to the depth of about half an inch. The crucible being closed, its lid is brought to a red-white heat. Its contents are then sounded with a hot iron rod, to ascertain if the nickel is reduced; after which the remainder of the tin is passed through charcoal, and the fused mass is stirred constantly until the combination of the metals is complete, when it is run into ingots or bars for use.

South Australian Copper Mines.—A prospectus has been issued of the Yudadamutana (South Australian) Copper Mining Company, with a capital of £45,000 in shares of £3. The object is to work some mines in the neighbourhood of Port Augusta.

APPLIED CHEMISTRY.

The Adulteration of Bees'-wax by Japanese wax is detected, according to Hager, by their different behaviour in a concentrated solution of borax, at the boiling point. Bees'-wax is totally insoluble in such a solution, while Japanese wax dissolves, and on cooling forms a milky white, gelatinous mass. From a mixture ot the two the latter is dissolved out, carrying with it a portion of the former, while another portion rises and congeals on the surfaee.

Amylaceous Matter in Fruits.—It is asserted by Peloze and Fremy that starch cannot be detected in green fruits, either by means of the microscope or by iodine. M. Payen shows that it can be easily recognised by iodine in the following way :—He takes a thin slice off a growing pear, apple, or quince, plunges it under water to avoid the action of the air, and to wash away soluble matters, and when the washing is complete, puts it into a weak alcoholic solution of iodine. In an hour or two an intense blue colouration is produced. He also recognised starch granules by the microscope. One curious fact observed was, that as the fruit ripened the starch first disappeared from the neighbourhood of the peduncle.

Gases given off by Plants under the Influence of Light.—M. Boussingault has discovered that under the influence of a direct sunlight the leaves of aquatic plants give off a notable proportion of carbonic oxide and carburetted hydrogen. He thinks that this emanation of carbonic oxide may be one of the causes of the unhealthiness of marshy districts. The fact he points out is important, and the subject will, no doubt, receive further investigation.

To recognize Grape Sugar beside Cane Sugar.—Employ triacetate of lead and ammonia, which produce with both sugars white precipitates, which after a while, particularly when heated, assumes a red colour in the presence of grape sugar, but remains unaltered by cane sugar; a small quantity of the former mixed with a large proportion of the latter may thus be recognised by the red tint of the precipitate.

Influence of Silicic Acid on Fermentation.—J. C. Leuchs states that silicic acid precipitated from water-glass, produces fermentation in saccharine solutions, particularly after the addition of some tartaric acid, and generates the odour of beer yeast, afterwards of fruits, and finally of ether; in very dilute solutions the odour of putrid yeast appears. Silicic acid does not lose this property by boiling with water or by repeated employment for fermenting and subsequent washing with water. A solution of sugar, containing alcohol and tartaric acid, fermented briskly with silicic acid, from which the gas was evolved, and amid the searation of a yeasty foam.

On the Preparation of Picramic Acid.—We are generally directed to dissolve picrate of ammonia in alcohol, saturate with ammonia, and then with sulphydric acid. These saturations are tedious and troublesome, and as picrate of ammonia is but sparingly soluble in alcohol, much of the latter is consumed, and the solutions are very bulky. The following process will be found greatly preferable :—Picric acid (which is very soluble in strong alcohol) is dissolved in cold alchohol, and excess of sulphydrate of ammonia added. The liquid then only requires to be evaporated over the water bath, the residue to be exhausted with boiling water, filtered, and treated with acetic acid. The picramic acid obtained in this way is very pure, and the quantity large. In one experiment, where the quantities were weighed, over 63 per cent. of the weight of the picric acid consumed was obtained. If too little sulphydrate be used, picric acid remains in the mother water, from whichthe picramic acid crystallises, and may be recovered by precipitating with carbonate of pot ash.

APPLICATIONS FOR LETTERS PATENT.

Dated January 24, 1862.

181. A. W. Williamson, Ph. D., F.R.S., University College, London—Tubulous boilers or steam generators.
182. J. Higgin, Manchester—Machinery for retarding and stopping railway carriages.
183. J. Cornforth and B. Smith, Birmingham—Machinery for boring or drilling gun-barrels and tubes.
184. W. Clark, 53, Chancery-lane—Manufacture of artificial flowers, leaves, and fruit.
185. J. Longhurst, Ticehurst—Chains and chain cables.
186. J. Rock, Hastings—Common road carriages.
187. J. W. Girdlestone, Birkenhead—Projectiles for fire-arms.
188. T. Morris and R. Weare, Birmingham, and E. H. C. Monckton, Fineshade, Northamptonshire — Submarine and other telegraphic communication.
189. C. G. Hall, Regent-street—Boots, shoes, and leggings.
190. A. Wallis and C. Haslam, Basingstoke—Thrashing machines.
191. J. Alison, Brightland, Reigate—Apparatus for tilling land by steam power.

Dated January 25, 1862.

192. W. Baker, Downham—Fire-arms.
193. W. Johnstone, Glasgow—Lamps.
194. C. West, 2, Derby-street, Westminster—Insulating and covering wire.
195. J. C. F. Meugin, Paris—Barcelonnettes or cradles for children or for dolls.
196. J. H. Johnson, 47, Lincoln's-inn-Fields—Prevention or removal of incrustation in or from steam generators.
197. D. Edleston and H. Gledhill, Halifax—Apparatus for finishing textile and other fabrics.
198. E. A. Curley, 4, Green-terrace, New River Head, Clerkenwell—Sewing machines.
199. J. Wright, Rochester—Constructing works below water.
200. F. J. L. Lefort, Bothey, Belgium—Invisible safety lock applicable to iron safes.
201. F. Roberts, Maiden Newton, and A. Roberts, Frome Vauchurch, Dorsetshire—Apparatus for ploughing or cultivating land.
202. J. Brown and J. Davenport, Bolton—Lubricator for pistons.
203. A. Samuelson, 28, Cornhill—Hydraulic presses, and the mode of working the same.

Dated January 27, 1862.

204. W. Smith, Manchester, and C. Tiesset, Boulogne-Sur-Mer—Manufacture of colours for dyeing and printing.
205. J. Lillie, Duke-street, Adelphi—New materials for the bottoms of sea-going and other vessels for the prevention of fouling.
206. S. A. Carpenter, Birmingham—Covering for crinoline skirts.
207. R. Martindale, Handsworth—Globes and glasses to be used with hydro-carbon lamps.
208. C. W Harrison, Lorimer-road, Walworth—Embossing apparatus.
209. W. Orr, Greenock—Apparatus for the manufacture of sugar.
210. J. Smith, Spring-row, Keighley—Rollers used in machinery for preparing, roving, and doubling fibrous materials.
211. W. W. Warren, 82, Parrock-street—The purpose of preventing the desecration of the dead for sanitary purposes.
212. T. J. Robotham, Burslem, and N. Hackney, Hanley—Purifying slip, glaze, and other potters' materials.

Dated January 28, 1862.

213. J. List, Carisbroke, Isle of Wight—Obtaining distances and heights and distances between distant objects without computation.
214. H. H. Treppass, 14, St. George's-terrace, Barnsbury-park—Construction of the kaleidescope.
215. S. Smith and T. Smith, Nottingham—Manufacture of cord and twine from mill spun yarns.
216. J. Hawkins, Bristol—Composition wash to be applied to marine and other steam boilers to prevent incrustation.
217. J. Hunt, Birmingham—Gas chandeliers.
218. M. A. F. Mennons, Rue de l'Echiquier, Paris—Engines actuated by heated air or by combinations of air and steam.
219. M A. F. Mennons, 39, Rue de l'Echiquier, Paris—Construction of looms for weaving.
220. A. H. Church, 170, Great Portland-street—Means of preserving stone and colour wash from the injurious action of atmospheric and other influences.
221. C. Culling, Downham-market, Norfolk—Fire-arms.
222. S. C. Lister and J. Warburton, Manningham, near Bradford—Preparing cotton for spinning.
223. G. H. Morgan and E. Morgan, Grand Junction-terrace, Edgeware-road—Carriages.
224. G. Chapman, Rutland-street, Leicester—Rotating circular knitting frames.
225. G. J. N. de Ridder, 57, Rue Pigale, Paris—Railway carriages for the conveyance of travellers and goods.
226. W. E. Newton, 66, Chancery-lane—Engines for pumping or forcing air or water.
227. W. Irlam, Gibraltar Iron Works, Newton-heath, Manchester—Improvements in the construction of railway crossings and turntables.
228. R. Bodmer and W. Wilson, Newport—Manufacturing artificial stones.

Dated January 29, 1862.

229. J. H. Brierley, Park-terrace, Halifax—A clasp or fastener for reversible belts, bands, or straps.
230. T. Clayton and W. Smith, Knowlwood, near Todmorden—An improved flyer.
231. F. D. de Boutteville, Fontaine-le-Bourg, Seine, France—Machinery applicable to the spinning of fibrous substances.
232. L. A. Pulvé, 15, Passage des Petites Ecuries, Paris—Fireproof iron chest and strong boxes.
233. J. McKean and J. Gabbott, Walmer-bridge Mills, near Preston—Sizing or dressing yarn or textile materials.
234. T. Meriton, 3, Leadenhall-street—Marine and other boilers for generating steam.
235. W. Clark, 53, Chancery-lane—Bleaching of textile materials for the manufacture of paper.
236. J. B. Harby, Leytonstone—Preserving electric telegraph cables and wires.
237. R. A. Brooman, 166, Fleet-street—Machinery for puddling metals.
238. B. Foster and J. Moore, Denholm—Apparatus for spinning and doubling wool and other fibrous materials.
239. W. E. Newton, No. 66, Chancery-lane—Printing machinery.
240. W. E. Newton, 66, Chancery-lane—Boxes for the journals of railroad carriage and other axles.
241. G. Bedson, Manchester—Wire fences.
242. M. Collier, Failsworth—Looms for weaving.

Dated January 30, 1862.

243. G. Phillips, the elder, and G. Phillips, the younger, 89, Holborn-hill—Distillation and rectification of alcohols or spirits.
244. M. Allen, 14, Worship-street, Shoreditch—Construction of buildings for the prevention of fire.
245. T. Gontard, 16, Rue des Vieux Augustins, Paris—Improved truss plates producing an upward pressure.
246. E. A. Rippingille, Staple-hill, near Bristol—Engines worked by steam or other fluids, and pumps.
247. J. Firth, Flush Mills, Heckmondwike, near Leeds—Finishing mohair cloth.
248. H. Robottom and R. Underwood, 31, Robert-street, Hoxton New Town—Watches and pocket chronometers.
249. W. Davies, Elizabeth-place, Old Bethnal Green-road—Apparatus for cutting corks and bungs.
250. W. Clark, 53, Chancery-lane—Mechanical wrenches.
251. A. C. B. Malois, 29, Boulevart St. Martin, Paris—Mechanical fabricatiou of boot and shoe heels.
252. A. Labousse, Brussels, Belgium—Manufacture of wheels for waggons, locomotive engines, and other vehicles used for railway purposes.

Dated January 31, 1862.

253. D. Littlehales, Brearley-street West, Birmingham—An improved plastic compound as a substitute for paper maché.
254. H. White, 13, Mornington-place, Hampstead-road—collars.
255. J. Silvester, West Bromwich—Pocket and other spring balances.
256. F. Baggett, Birmingham, and J. Sanger, Aston, near Birmingham—Breech-loading small arms.
257. H. Schatten, Hesse Cassel—Gas meters.
258. J. Dodge, Little Portland-street—C springs for carriages when used without a perch.
259. W. Walton, Manchester, and F. Walton, British Grove Works, Chiswick—Wire cards.
260. G. Mehrtens. 27½, Charles-street, Hampstead-road—Ladies' stays.
261. J. Hargreaves, 12, Clifton Cottages, Clifton-road, Peckham—Manufacture of pipes or tubes for conveying water.
262. P. Scheurwegh and A. J. A. H. de Boisscrolle, Paris—Improvements in treating fatty and oily matters.
263. C. Pontifex, 55, Shoe-lane—Apparatus for cooling or heating fluids or liquids.
264. E. H. C. Monckton, Northampton—Obtaining ammonia and other useful products by means of electricity direct from the atmosphere.
265. T. Stephens, Coventry—Manufacture of book markers.
266. J. Gibbins, 30, London-wall—Composition for coating wood, metal, and other materials.
267. A. Forsyth, Glasgow—Manufacture of frames for advertising purposes.
268. C. Veronique, Rue Thaitbout, France—An improved wrapper garment.

Dated February 1, 1862.

269. W. Smith, Bury—Machinery for the manufacture of bricks.
270. L. Fauvel, Paris—Apparatus for indicating the existence of escapes in gas tubing.
271. R. Burkhardt and C. Doebler, Manchester—Æolian harps.
272. J. Pendlebury, Dukinfield, Chester—Lubricating steam engines.
273. J. Hill, 212, Piccadilly—Construction of portable chairs.
274. J. Deprez, Auzin, du Nord, France—Direct digging of mines.
275. F. W. Daehne, Swansea, Glamorganshire—Furnaces used in the manufacture of zinc.
276. T. Cook, Coburg-road, Old Kent-road—Machinery for punching, cutting, and pressing metals and other materials.
277. J. Harris, Store-street, Tottenham-court-road—Mattresses, squabs, pillows, and other like articles of furniture.
278. T. Cook, Coburg-road, Old Kent-road—Machinery for folding envelopes.
279. W. Clark, 53, Chancery-lane—Machinery or apparatus for the manufature of festooned edging or material.
280. F. Riesbeck and W. Becker, Aldermanbury—Locks or fastenings for bags.
281. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Recovery of the oleic acid contained in the residual scouring waters of woollen.

Dated February 3, 1862.

282. L. Hill, Port Glassgow—Applying armour plating to war ships.
283. D. Joy, Manchester—Machinery for forging metals.
284. C. W. Lancaster, New Bond-street—Strengthening cast iron ordnance.
285. C. Stevens, 31, Charing-cross—An improved axletree.
286. J. J. King, Chase Lodge, Lavender-hill, Wandsworth-road—Fastenings of bedsteads.
287. W. E. Newton, 66, Chancery-lane—Machinery for spinning.
288. W. Clark, 53, Chancery-lane—Processes for preserving and colouring wood.

Dated February 4, 1862.

289. T. M. Meekins, 44, Chancery-lane—The production of a projectile and explosive force.
290. G. Manwaring, Southampton—Flushing apparatus for closets.
291. C. M. Roullier, Paris—Employing waste leather.
292. P. Gardillanne, Dax, France—Metallic closing of hoop iron.
293. J. L. Norton, 38, Belle Sauvage Yard, Ludgate Hill—Beating, stretching, and drying fabrics.
294. R. A. Brooman, 166, Fleet-street—Manufacture of hard and soft soaps.
295. J. Greenwood, Portland Mills, Bradford—Means or apparatus for preparing and combing wool and other fibres.
296. W. W. Williamson, High Holborn—Apparatus for drying clothes and fabrics.
297. J. Webster, Birmingham—Gas fittings.
298. W. E. Newton, 66, Chancery-lane—Manufacture of iron and steel.

Dated February 5, 1862.

299. D. Gallafent, 15, Stepney Causeway—Mode or modes of generating or producing elastic vapours to be used as a motive power.
300. W. E. Taylor, Enfield, Lancashire—Carding engines.
301. J. King, Chadshunt, Warwickshire—Lubricators for lubricating the moving parts of machinery.
302. E. F. Smith and T. Swinnerton, Dudley, Worcestershire—Manufacture of coke.
303. J Browning, Minories—Aneroid barometers.
304. H. Ashworth, Littleborough, Lancashire—Apparatus employed in spinning cotton and other fibrous substances.
305. E. Harrison, Oldham, Lancashire—Certain compounds to be used as a substitute for gunpowder.
306. W. Campion and H. Johnson, Nottingham—Apparatus for making the welts of hose.
307. J. Lee, Church Gate, Leicester—Traction engines.
308. J. B. Payne, Chard, Somersetshire—Treatment or preparation of hemp.
309. A. V. Newton, 66, Chancery-lane—An improvement in fire arms.

Dated February 6, 1862.

310. C. Calow, Newton Heath, and J. W. Hirst, Manchester—Slide valves for steam engines and other similar purposes.
311. A. C. Bamlett, Middleton Tyas, Yorkshire—Reaping and mowing machines.
312. J. Pitkin, Clerkenwell—An improvement in aneroid barometers.
313. R. Russell, Derby—Stove grates and kitchen ranges.
314. R. Shortrede, Brighton—Construction of ships of war with armour plates.
315. P. H. Astley, 4, Matthew's-place, Stratford, Essex, and C. Leighton, 3, Manby-grove, Manby-park, Stratford, Essex—Floating of vessels.
316. M. Henry, 84, Fleet-street—Obtaining and applying motive power.
317. E. C. Willis, Addison-road, Kensington—Treatment of wax and other substances of a similar nature.
318. E. T. Bellhouse and W. J. Dorning, Manchester—Construction of hydrostatic presses suitable for packing cotton.
319. J. H. Johnson, 47, Lincoln's-inn-Fields—Preparation of pulp for paper.
320. J. Tonkin, Pool, Illogen, Cornwall—Manufacture of gunpowder.
321. J. D. Dunnicliff, Nottingham—Manufacture of lace or net bonnet fronts.

Dated February 7, 1862.

322. R. A. Brooman, 166, Fleet-street — Stereoscopic, albums, books, and cases.
323. J. Lloyd, Donnington — Buffers for engines and carriages on railways.
324. P. Shaw, Edinburgh—Lamps.
325. H. A. Silver, Silvertown - Manufacture of trays, cases, and other similar articles in ebonite, vulcanite, or other hard india-rubber.

326. W. E. Gedge, 11, Wellington-street, Strand—Thrashing and winnowing machine.
327. A. McKenzie and F. Panthel, Glasgow—Sewing machines.
328. W. Clark, 53, Chancery-lane—Preserving timber.
329. H. Macauley and A. F. Notley, Rotherham—Fire guards.
330. W. H. Bartholomew, 2, Warwick Villas, Leeds—Barges or vessels suitable for the navigation of canals and rivers.
331. H. Brinsmead, Ipswich—Apparatus for moving, elevating, cleaning, and dressing grain.

Dated February 8, 1862.

332. J. S. Woodhouse, Cheapside—Hooped skirts.
333. J. Howie, Hureford Colliery, Kilmarnock—Regulating the consumption of fuel in furnaces.
334. J. A. Knight, 4, Symond's-inn, Chancery-lane.—Washing machines.
335. F. Tolhausen, 35, Boulevart Bon Nouvelle, Paris—Manufacturing the tyres of railway wheels by hydraulic pressure and steam.
336. J. Webster, Birmingham—Manufacture of certain descriptions of nails.
337. J. Carrington, Queen's Gate Mews, Kensington—Construction and fitting up of stalls and horse boxes.

Dated February 10, 1862.

338. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Treatment of coprolites and other fossil phosphates of lime.
339. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Vapour baths.
340. J. Dickson, 66, Tollington-road, Holloway—Voltaic apparatus.
341. R. Philp and J. Philp, Lower John-street, Golden-square—Improvement in propellers for propelling ships.
342. J. Busfield, and J. Eastwood, Bradford, Yorkshire—Apparatus for preparing wool for dyeing and spinning.
343. B. C. T. Pim, Junior United Service Club, and G. Fawcus, North Shields—Uniting iron plates, and fixing armour plates in ships.
344. L. R. Bodmer, 2, Thavies Inn—Hydraulic oil presses.
345. G. Smith, Holland Grove, North Brixton—Shawls.
346. J. Danks, 56, Webber-row, Waterloo-road—Manufacture of door mats and hearth rugs.
347. W. Clark, 53, Chancery-lane—Reflectors.
348. A. Munck and H. A. Myhre—Berners-street, Oxford-street—Ships' logs.
349. W. Clark, 53, Chancery-lane—Refining cast-iron.

Dated February 11, 1862.

350. W. H. Weaver, Edington, Bridgnorth, and C. Gall, Bridgnorth, Shropshire—Machinery for agricultural purposes.
351. T. Fyfe, 46, Leicester-square—Knapsacks.
352. C. Bonell and W. M. Spiring, Wednesbury, Staffordshire—A new or improved rotary engine.
353. E. Sutton, Radcliffe, Lancashire—Apparatus for preparing cotton for spinning.
354. W. Macnab, Greenock—Steam engines.
355. W. Lyall, Amiens, De la Somme, France—Preparing flax, hemp, and other fibrous substances.
356. W. Wood, Monkhill, Pontefract—Manufacture of pomfret or liquorice cakes.
357. J. H. Johnson, 47, Lincoln's-inn-Fields—Smoothing irons.
358. J. Brinsmead, Charlotte-street, Fitzroy-square—Pianofortes.
359. R. Johnson, Manchester—Welded wires used for telegraphic and other purposes.
360. G. Lindemann, Manchester—Applying gas for the purpose of singeing or dressing yarns or threads.
361. J. J. McComb, Pump-court, Temple—Fastening for securing cotton.
362. F. J. Bolton, 7, Bolton-row, Mayfair—Rifle and gun-stoppers and oil bottles.
363. J. Hetherington, Manchester—Apparatus for preparing cotton for spinning.

Dated February 12, 1862.

364. G. J. Aman, Liverpool—Wrappers for holding samples of grain and other dry substances.
365. F. Tolhausen, 17, Rue du Faubourg Montmartre, Paris—A new system of vertical steam boilers.
366. J. Robb, Aberdeen—Ventilating.
367. J. Brickhill, 5, Stepney Causeway, Commercial-road East—Cylinders and pistons of steam engines.
368. T. Coltman, Leicester—Sewing machines.
369. A. Hinshaw, Aldermanbury Postern—Hooped skirts.
370. R. A. Brooman, 166, Fleet-street—Preparing and ornamenting cast iron.
371. J. S. Joseph, Rhostyllan, near Wrexham, Denbighshire—Coke ovens.
372. T. Spencer, Liverpool—Propellers for navigable vessels.
373. A. Samuelson, 28, Cornhill—Building ships and vessels.
374. T. Horsley, 10, Coney-street, York—Breech-loading fire arms.

Dated February 13, 1862.

375. W. E. Newton, 66, Chancery-lane—Projectiles.
376. J. S. Joseph, Rhostyllan, near Wrexham, Denbighshire—Retort oven.
377. J. Peters, Ulverston, Lancashire—Portable steam engines.
378. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Disinfection of animal excretions.
379. W. Williams, Bath—Pianofortes.
380. W. Hewitt, Birmingham—Rein holders.
381. A. C. Ebbutt, 25, Blackman-street, Southwark—Improved self-adjusting easy chairs.
382. W. H. Brown, Camberwell—An improvement in yards, fore and aft booms, and gaffs.
383. C. D. Abel, 20, Southampton-buildings, Chancery-lane—Towing boats or other vessels on rivers.
384. T. Davison, Belfast—Improved means for preventing the corroding of steam boilers.
385. F. Falconer, Glasgow—Lamps.
386. J. F. Lawton and J. Lawton, Vale Mill, Micklehurst, Cheshire—Manufacture of flannel for shirtings and other articles of apparel.
387. R. Hornsby, Spittlegate Works, Grantham, Lincolnshire—Apparatus for thrashing and separating grain.
388. W. D. Allen, Laithfield House, Norfolk-road, Sheffield—Manufacture of stamp heads.
389. G. C. Burrows, Stoke Holy Cross, Norfolk—Lounges, seats, or other apparatus for sitting or reclining on.
390. E. E. Allen, 5, Parliament-street, and J. Stewart, Blackwall—Construction of steam-engines.
391. J. E. McConnell, Wolverton, Buckinghamshire—Parts of boilers and furnaces for locomotive and other engines.
392. E. Green and J. Newman, Birmingham—Buttons for fastening and ornamenting certain articles of dress.
393. J. E. McConnell, Wolverton, Buckingham—Railway breaks, and warming railway carriages.
394. A. Jansen, Brussels—A new ball for fire-arms.
395. W. G. Valentin, Royal College of Chemistry, Government School of Mines, Oxford-street—Apparatus for coking coal.

Dated February 14, 1862.

396. S. B. Whitfield, Birmingham—Iron bedsteads, and ornamental iron tubes or columns for the construction and ornamentation of iron bedsteads.
397. A. J. Dodson, Clapham—Composition for coating covering, or protecting ships' bottoms, applicable also for coating or covering railway sleepers, telegraphic wires, and other surfaces, and likewise as a cement and as a substitute for metal for certain constructive purposes.
398. W. Clark, 53, Chancery-lane—Mounting and fixing the handles or knobs of doors, furniture, and other articles.
399. T. D. McFarlane, Glasgow—Sewing machines.
400. J. H. Johnson, 47, Lincoln's-inn-fields—Machinery for propelling ships and boats.
401. W. F. Smith and A. Coventry, Salford—Laths for turning and cutting screws.

Dated February 15, 1862.

402. H. Colwell, 14, Davies-street, Saint George, Hanover-square—Truss for hernia, prolapsus uteri, and prolapsus ani.
403. T. Renison, Glasgow—Water closets.
404. J. H. Johnson, No. 47, Lincoln's-inn-Fields—Timekeepers.
405. W. Avery, Birmingham—Machinery for the manufacture of screws, a part or parts of which improvements may also be used in the manufacture of pins, rivets, and nails.
406. G. H. Law, 17, Rochester-road, Camden New Town—Construction of steam and other boilers.
407. J. Wall and T. Dodd, Liverpool—Construction and arrangement of apparatus for regulating the flow or passage of fluids.
408. C. Turner and J. Shaw, Leeds—Felted fabrics.
409. T. Horsley, York—Apparatus for turning and closing the cartridges of breech-loading fire-arms.
410. J. Cooke, Willington—Marine propulsion.
411. D. Kyle, Westminster—Communicating or signalling in and with railway trains.
412. R. Bunting, Sheffield—Bolsters and scales, and machinery employed therein.
413. J. Chatterton, Highbury, and W. Smith, Dalston—Telegraph cables.
414. R. Bell, Dublin—Treating fabrics or articles composed of animal and vegetable substances for the purpose of separating one class from another.
415. A. Harrison, 16, Park-place, Highbury—Under-garment for gentlemen and ladies' wear.
416. J. Green, Newtown, Worcester—Apparatus for signalling, which improvements apply to signals used with steam ploughs or cultivators.
417. J. Russell, Camberwell—Method of raising sunken, submerged, or stranded vessels.

Dated February 17, 1862.

418. F. Gerish, East-road, City-road—Pumps.
419. H. Crawford, J. Crawford, R. Crawford, and R. Templeton, Beith, Ayr—Looms for weaving.
420. J. Hodgkinson, and D. Greenhalgh, Bolton—Machinery for preparing or combing cotton, wool, and other fibrous materials.
421. J. Whitaker, Leigh—Machinery for pulping roots.
422. J. Van den Berg, Hague, Netherland—Economical fire kindler.
423. E. Hughes, 123, Chancery-lane—Apparatus for collecting the gases given off from furnaces.
424. T. Birdsall and J. Birdsall, Leeds—Preparing hides or skins for tanning.
425. J. Coombe, Belfast—Machinery for winding cops, and in the treatment of cops for warps and other purposes.

Dated February 18, 1862.

426. H. E. Quant and G. H. Fisk, 1, High-street, Manchester, and W. Dawes, Bolton, Lancashire—Securing the ends of steel used for crinolines.
427. J. H. Hastings and J. Freezer, Holkham, and J. Woods, jun., Wells, Norfolkshire—Ploughs.
428. R. Watkins, 14, Lower Belgrave-place, Pimlico—Producing light in oil and spirit lamps.
429. C. D. Ségoffin, 4, South-street, Finsbury—Apparatus for looking at photographic cards.
430. J. Lees, Rookery, Salterhebble, near Halifax—Trap for catching rats.
431. W. Clark, 53, Chancery-lane—Gas apparatus used for lighting cigars and other tobacco.
432. M. Henry, 84, Fleet-street—Cartridges.
433. W. Bush, Tower-hill—Omnibuses and other carriages.
434. W. Firth, Burley—Machinery for digging or turning up soil.

Dated February 19, 1862.

435. C. T. Marzetti and J. Watson, Vine-street, Minories—Apparatus for raising, lowering, and otherwise moving or disposing casks and other heavy bodies.
436. J. T. Pendlebury, Elton, and G. Pendlebury, Tottington-lower-end—Machinery for doubling, folding, or plaiting cloth.
437. H. B. Barlow, Manchester—Carding or otherwise preparing cotton and other fibrous materials and machinery employed therein.
438. J. Nasmyth, Brussels—Method of obtaining motive-power and of applying it.
439. F. Barnett, 230, Oxford-street—Lamp or lantern for street lighting and other purposes.
440. W. Adams, Hampstead—Springs, and their arrangement for moving and stationary purposes.
441. N. Symons, St. Pancras, London—Improving the power of steam-engines by a different form of piston, internal top and bottom of cylinders, also for increased strength and lightness for all kinds of wheels, framework girders, blades of blowing fans, and paddle wheels.
442. J. Turner, 194, Upper Thames-street—Machinery for mixing, mincing, and pounding.
443. W. Hinton, Greville-street, Holborn—Barometers.
444. W. Davis, Stoke Newington—Increasing the illuminating effect of coal gas and other gases.
445. J. Paterson, Middle Temple—Means or apparatus for re-burning animal charcoal.
446. J. Gregory, Wellington—Candlesticks.
447. G. Bousfield, Brixton—Protecting iron boilers, tanks, and vats from wear arising from galvanic action.
448. J. Wilcox, Ludgate-hill—Manufacture of frills or ruffles, and in the machinery or apparatus employed therein.

Dated February 20, 1862.

449. G. Lee, New Bridge-street, London—Tourniquets.
450. J. Friedlaender, White Abbey, Antrim—Machinery for scutching, breaking, and preparing flax, hemp, jute, and other fibrous materials.
451. E. Stoehr, Manchester—Manufacture of manganese, and in the combinations of manganese with other metals.
452. D. Wilkie, Wapping—Ship's compass, which is not to be affected by local attraction or deviation, to be used by sailing vessel or steamer.
453. J. Bleasdale and F. Borland, Accrington, Lancashire—Fluted rollers for preparing and spinning fibrous materials, and the mode of manufacturing the same.
454. R. Pritchett, Westminster—Targets or butts.
455. J. Paterson, Middle Temple—Use of animal charcoal.
456. J. Paterson, Middle Temple—Apparatus for facilitating the evaporation of saccharine solutions.
457. C. Wood, Bramford, Suffolk—Horse rakes.
458. Lord A. S. Churchill, 16, Rutland-gate, Hyde Park—Electric telegraphs.

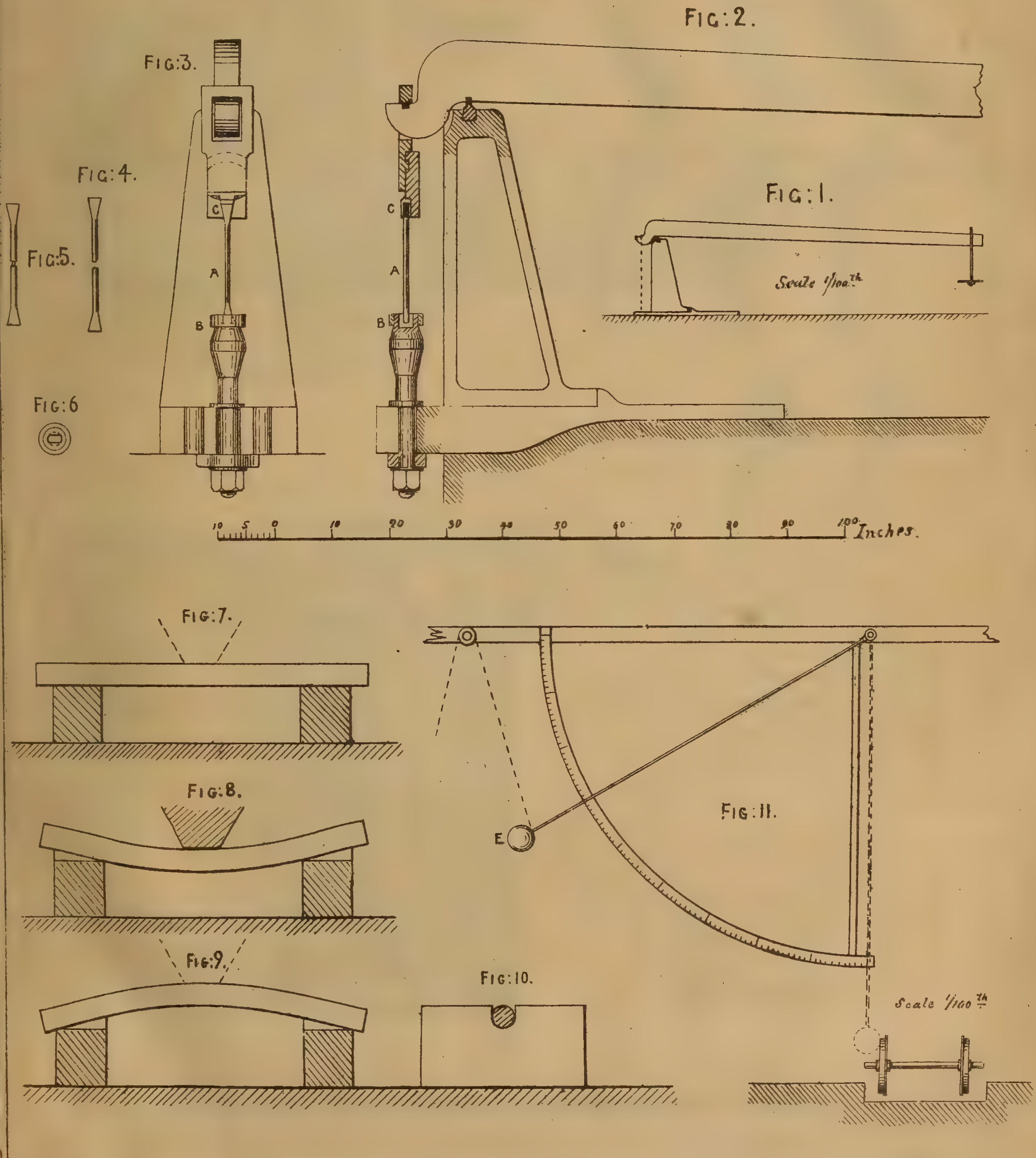
Dated February 21, 1862.

459. J. Spence, Liverpool—Floating apparatus for transhipping grain, salt, and other substances in bulk from from one navigable vessel to another.
460. R. H. Skellern, Surrey—Self-inking hand stamp or press.
461. H. Ward, Warwickshire — Improvements in ladies' saddles.
462. J. Standish and J. Gooden, Lancashire—Apparatus for stripping or cleaning the flats of carding engines.
463. W. Hamer, Lancashire—Apparatus employed in the preparation of cotton and other fibrous materials.
464. E. S. Crease, Gracechurch-street, London—Machinery for drilling, boring, or excavating rock or other earthy substances.
465. R., and W. E. Pickin, Birmingham—Carriage bodies.
466. J. Krasuski, Paris—Apparatus for mastering fiery horses.
467. W. McAdam and W. Chrystal, Glasgow—Sheaves or pulleys, journals, bushes, and other similar bearing or rubbing surfaces.
468. S. Smith, Holborn — Electro-magnetic engines for obtaining and applying motive power.

Dated February 22, 1862.

469. H. Chavasse, T. Morris, and G. B. Haines, Birmingham—Manufacture and ornamentation of metallic bedsteads, part of which is also applicable to other articles.
470. W. Ashton, Manchester—Manufacture of braids and similar articles.
471. W. H. Ross, Liverpool—Manufacture of sugar.
472. J. Kirkwood, Renfrew—Looms for weaving.

APPARATUS FOR TESTING THE TENSILE STRENGTH OF STEEL.



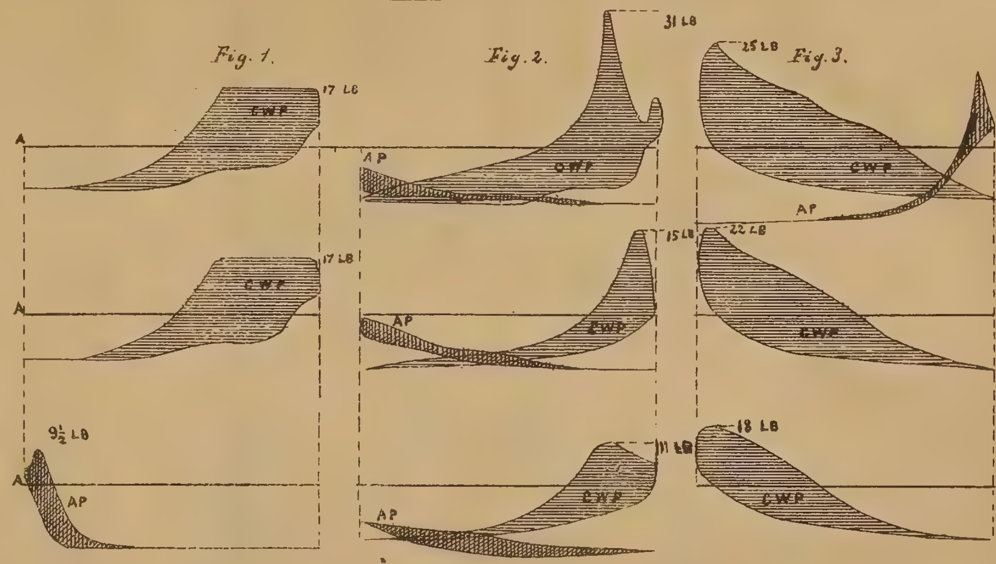
W Smith, C.E. direx.

Mr. J. F. SPENCER'S PAPER ON SURFACE CONDENSATION.

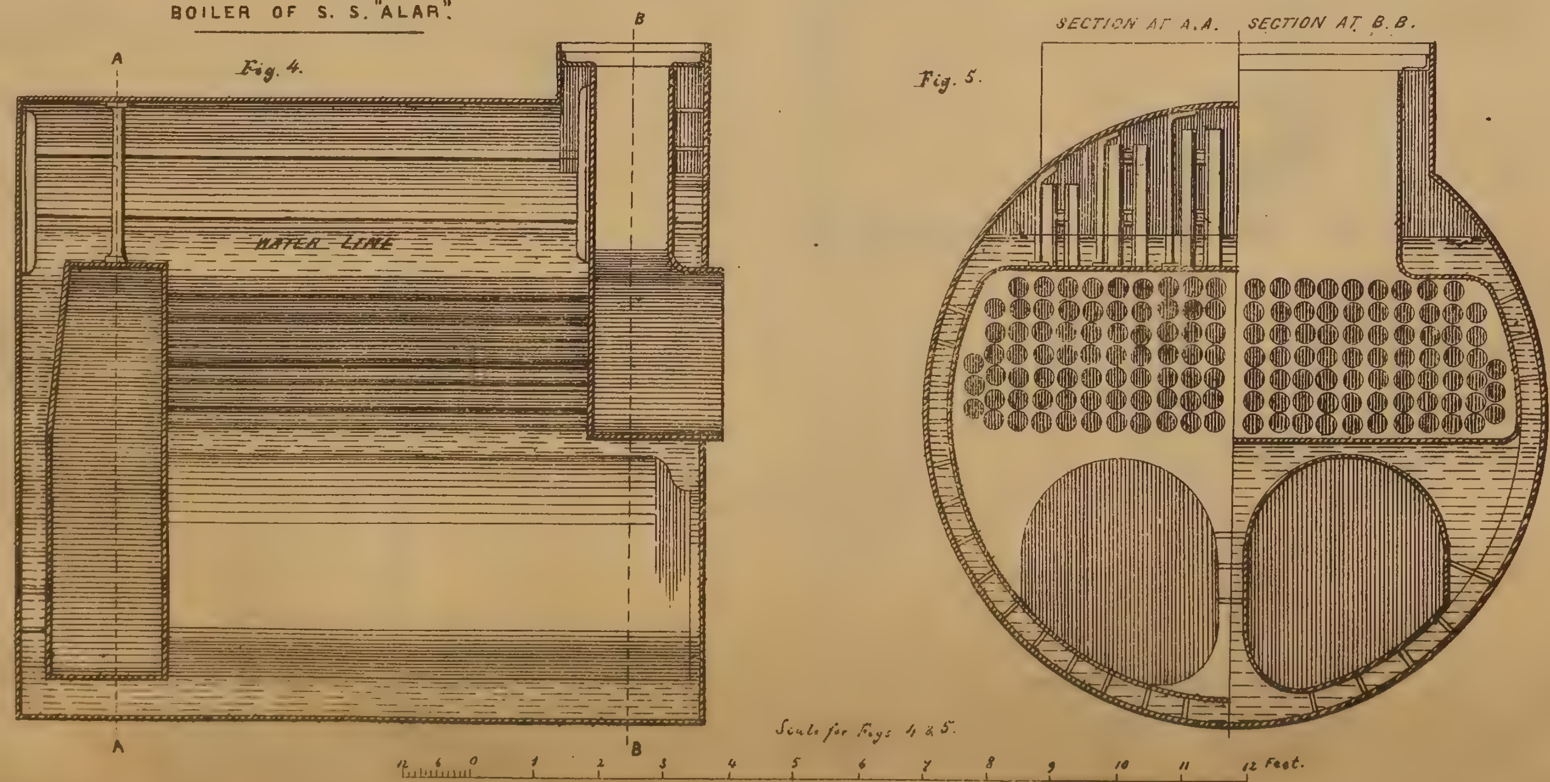
FIGURES.	1.	2.	3.
Nominal HP	165	100	50
Diameter C.W.P.	24 ins.	14 ins.	9 ins.
Stroke C.W.P.	16 ins.	16 ins.	12 ins.
Diameter A.P.	24 ins.	14 ins.	9 ins.
Stroke A.P.	16 ins.	16 ins.	12 ins.
Revolutions	70	80	115

Scale for Figs. 1. 2. & 3.

CONDENSING & AIR PUMP DIAGRAMS.

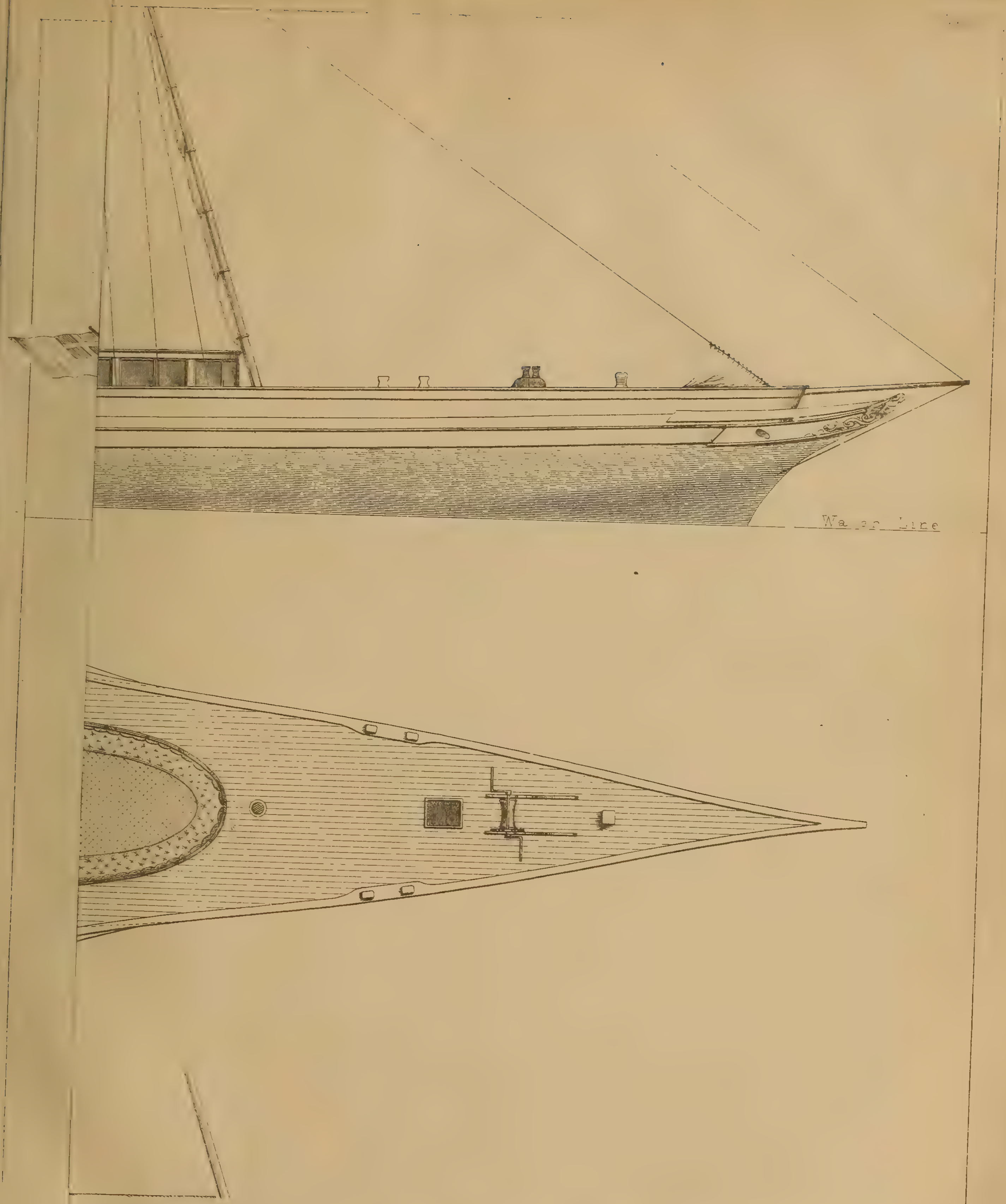


BOILER OF S. S. "ALAR".



Scale for Figs. 4 & 5.

W. Smith. C.E. direx.



"LADY OF THE LAKE"

DESIGNED BY MR JAMES ASH,

BUILT BY THE THAMES IRON WORKS COMPANY.

Scale ⅛ of an Inch to 1 Foot.

FIG. 1. ELEVATION.

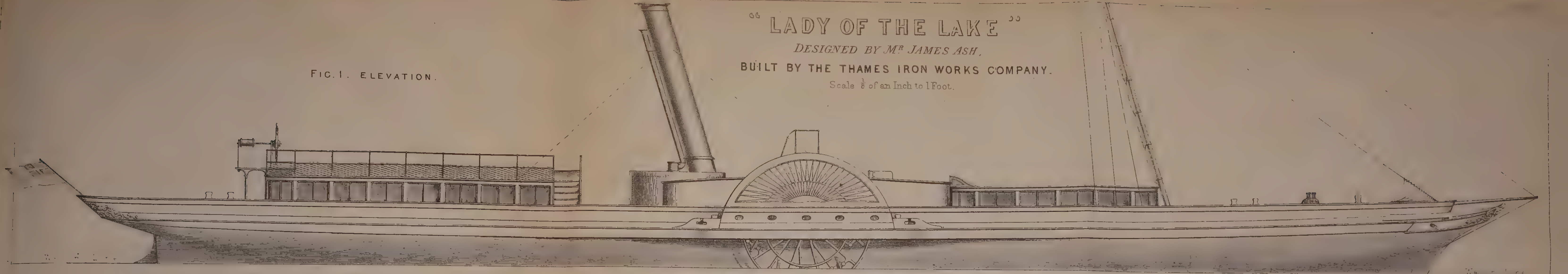


FIG. 2. DECK PLAN.

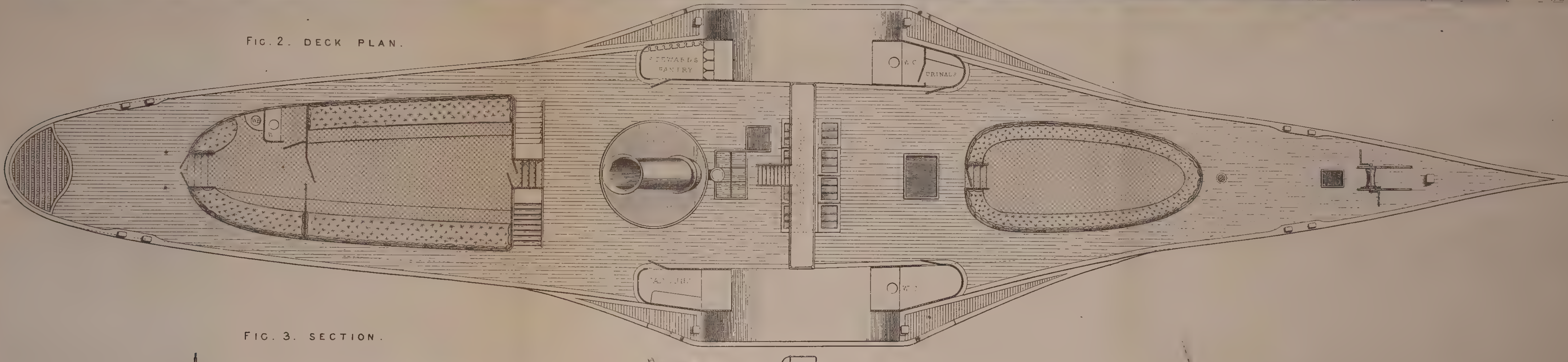
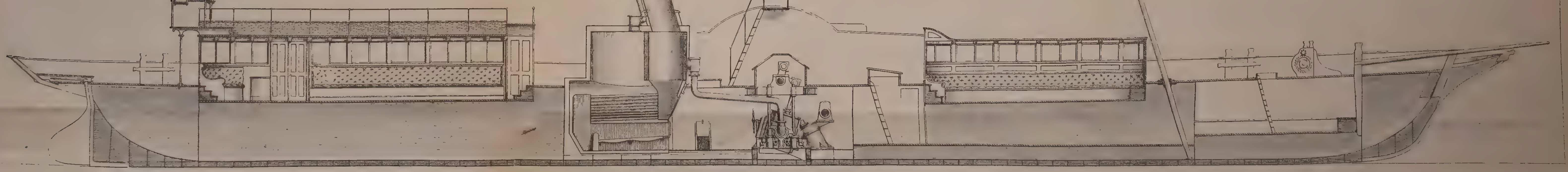


FIG. 3. SECTION.



THE ARTIZAN.

No. 232.—Vol. 20.—APRIL 1, 1862.

LIQUID DIFFUSION—DIALYSIS.

Many years since Professor Graham pointed out the existence of a remarkable physical law, governing the relation of gaseous bodies and vapours with regard to their admixture one with another. He discovered that when two gases or vapours, or a gas and a vapour, were brought in contact, there existed a peculiar tendency for the atoms or particles of one of these bodies to insinuate themselves, as it were, between and amongst the atoms of the other and *vice versâ*, until a complete mixture of the two was effected, or, as it was said, one gas had diffused itself into the other. This mixture or diffusion is altogether independent of any mechanical mixing by agitation, and often takes place in direct opposition to gravity; as when carbonic acid, a heavy gas, placed in a vessel below, rises as it will do through a narrow tube to diffuse itself into hydrogen, a light gas, placed in a vessel above the hydrogen descending at the same time, also against gravity, to diffuse into the carbonic acid below. This is spoken of as the diffusion of gases, its laws were completely investigated by Graham, and it was found by him invariable as to its principle, although the diffusive power possessed by different gases varied in extent.

Of late years Professor Graham has extended his inquiries beyond the gases and vapours, and he has lately disclosed the interesting and most important chemical fact, that the laws of diffusion operate in the case of a great number of liquids, which, like the gases, possess the property of mixing more or less quickly when quite at rest, and by virtue of the tendency of the atoms of one liquid or substance in solution, to insert themselves between the atoms of another liquid or solution and *vice versâ*, and the result is diffusion and mixture, more or less complete. This is *liquid diffusion*.

Liquid diffusion appears, however, to be far more limited in its operation than that which takes place between gases and vapours, and *a priori*, this might be expected from the greater degree of mobility existing between gaseous atoms than between those of liquids. Nevertheless diffusion occurs between certain liquids as between gases with certainty, and it seems to be just as much reducible to fixed laws; but whereas all gases and vapours are subject to this law, there are some liquids between which there is no diffusion whatever, when they are brought in contact.

If into a vessel of some depth, a glass beaker for instance, a quantity of water is poured, and upon that, very gently, a layer of oil, we shall have the two liquids resting in complete contact, forming two perfectly distinct layers, and between those liquids no diffusion whatever will occur. The line of separation will remain always sharp and definite—immediately above it will be pure oil, below it pure water. If instead of oil and water we pour into such a vessel, first water and then alcohol, so gently and with such precautions that no mechanical mixture occurs, we shall find, after some time, that the water will have ascended into the alcohol, and the alcohol have descended into the water, the completeness of the diffusion depending upon the period which elapses before the examination is made.

Professor Graham's long continued experiments have enabled him to classify liquids with respect to their power of diffusion. Certain liquids being pre-eminent for their diffusibility, others for want of that property, have been made the types of the classes, diffusible and non-diffusible liquids. Of the former the most remarkable are the solutions of crystallized salts, for instance common salt; of the latter, solution of gelatine, caramel, and tannic acid. So gelatine has been taken as the type of the non-diffusibles, and from its Greek name they are distinguished as the *colloids*; whilst crystallized salts in solution are adopted as the type of the diffusible liquids, which are thence called *crystalloids*.

When Professor Graham was engaged in his investigations of the diffusible properties of gases, he discovered that if the gases were separated from each other by certain media, diffusion went on as well as if they were in absolute contact, such media being permeable to the gases in a peculiar and specific manner. So it is with liquids, and in order that diffusion may take place from one liquid into another it is no more necessary that the liquids should be in contact than it was for the gases under similar circumstances. If the liquids be separated by a suitable medium, diffusion will still go on in the most complete and beautiful manner. Suppose for instance that a large beaker is half filled with water, or solution of a diffusible substance, and a smaller vessel having the bottom formed of a piece of bladder, or the substance now known as parchment paper, to form a permeable septum, and containing also a solution of some diffusible substance, be introduced into the beaker and lowered into it sufficiently for the bladder, or paper parchment bottom, to be half an inch below the level of the liquid in the beaker; diffusion between the liquids will go on just as if they were in contact. That in the beaker will enter the internal vessel, and that in the internal vessel will diffuse into the liquid contained in the beaker. This kind of liquid diffusion is called *Dialysis*. If, however, instead of introducing into the inner vessel a crystalloid, or diffusible substance, we put into it a solution of caramel or tannic acid, or any other colloid, no diffusion will take place; the colloid will not pass out, nor the crystalloid pass in; but if pure water is put into the beaker, and a mixture of caramel with common salt or any metallic salt into the inner vessel, then the diffusible substance will pass through the septum into the pure water, but the non-diffusible substance will be retained in the inner vessel, and this action will continue until a complete separation occurs between the mixed substances.

It is not the least remarkable feature of this curious property of liquids, that in regard to it, some substances, which are ordinarily in one of the classes described—in that of the crystalloids, for instance—may, by peculiar treatment, be made to acquire properties which transfer it at once to the other class. Silicic acid and alumina, which, under common circumstances, are crystalloids, may be brought into the state of colloids, and may then be obtained in solution in water in a very peculiar condition, being separated from the principles with which they were previously associated, and which have all been made to pass away by diffusion.

There can be little doubt that this discovery is destined to play an important part in relation to the chemistry of the day. It places in the hands of the chemist a powerful and very advantageous means of performing certain chemical operations without the intervention of chemical agents, and others, which, with the assistance of such agents, are extremely difficult of accomplishment.

It is also probable that certain natural phenomena of a recondite character may receive some elucidation by the further study of the laws of liquid diffusion.

THE PADDLE STEAMER "LADY OF THE LAKE."

(*Illustrated by Plate* 211.)

In the October number (of last year) of the ARTIZAN, we referred to this fine steam vessel—built by the Thames Iron Works Co., from the design of Mr. James Ash—and which in her trial trip attained a speed of 16 miles per hour. The *Lady of the Lake* has since continued to give highly satisfactory results in her actual performance; and as we have been asked for further particulars by several correspondents, we have now the pleasure of presenting our readers with a large copper plate engraving, representing three views (viz., elevation, deck plan, and longitudinal section) of this vessel.

We may here repeat the chief dimensions of the *Lady of the Lake* are as follows:—length between perpendiculars, 140ft.; length of keel, for tonnage, 129ft. $2\frac{1}{4}$in.; extreme breadth, 18ft.; depth in hold, 8ft. 3in.; tonnage, $222\frac{62}{94}$. Her engines by Messrs. Stewart and Sons, Blackwall, are collectively of 60 nominal horse-power.

USEFUL NOTES AND FORMULÆ FOR ENGINEERS.

(*Continued from page* 52.)

SECTION II.

In this section we purpose treating of the various forms of trussed and lattice girders.

Lattice girders differ only from the ordinary plate girders in having the continuous web between the top and bottom horizontal members, replaced by a series of inclined bars, through which the strains produced by the load pass, acting longitudinally upon them, tension or compression, according to their position.

On the top and bottom members there is also a direct longitudinal strain. Under the head of lattice girders, is usually included Warren, trellis, and other forms of braced girders, in which the successive bars on each side of the centre of the girder, make equal angles with a vertical line.

RESOLUTION OF STRAINS ON BRACED GIRDERS GENERALLY.

Let A B (Fig. 17), represent a braced girder, consisting of top and bottom horizontal members, and one series of triangles.

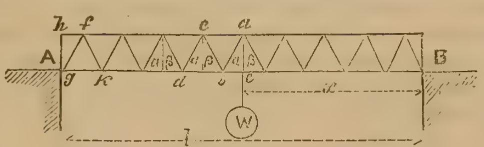


Fig. 17.

We will first consider the case of a load W placed at the centre of the girder, and resolve the strains produced by this weight, without regard to the weight of the girder itself.

Let the diagonal bars make angles a and β, with vertical lines $a\,c$ *etc.* Then W will be borne by the piers A B, the strain on each being determined by the position of W.

Let x be the distance of W from the pier B, and l be the span of the girders, then the weight borne by the pier A $= \frac{W\,x}{l}$, and therefore $\frac{W\,x}{l}$ is the load acting upon the part $f\,a\,c\,a$ of the girder.

If the straight line $a\,c$ represents the load $W\,x$, we find by the principle of the parallelogram of forces that the strain on $a\,b$ is represented by the length of $a\,b$, and similarly for the other bars in the girder.

The most convenient method of finding the lengths of the various bars, is by resolving the triangles $a\,c\,b$, $a\,b\,c$, $b\,c\,d$, &c., $f\,g\,h$.

The load $\frac{W\,x}{l}$ produces a compressive strain on $a\,b = \frac{W\,x}{l}$ sec. a.

This is resolved at the point b into two tensile strains, one on $b\,c$

$$= \frac{W\,x}{l} \text{ sec. } \beta\,;$$

and the other on $b\,e$,

$$= \frac{W\,x}{l} \text{ sec. } a \text{ sec. } \beta \text{ sin } (a + \beta)$$

$$= \frac{W\,x}{l} \text{ (tan. } a + \text{tan. } \beta)$$

the first of these strains is again resolved into two strains in compression; on $c\,d$

$$= \frac{W\,x}{l} \text{ sec } a.$$

and on $a\,c$

$$= \frac{W\,x}{l} \text{ sec. } \beta \text{ sec. } a \text{ sin. } (a + \beta)$$

$$= \frac{W\,x}{l} \text{ (tan. } a + \text{tan. } \beta)$$

and the triangles being similar there will be similar strains on similar bars, throughout the girder.

This will hold good for every part of the girder, except $g\,k$, the extremity of the tension members, where the strain $f\,g$ is resolved vertically and horizontally, instead of horizontally and diagonally, the strain on $g\,k$

$$= \frac{W\,x}{l} \text{ tan. } d$$

On every bar making an angle with the vertical line, there is a compressive strain,

$$= \frac{W\,x}{l} \text{ sec. } a$$

and on every bar making an angle β with the vertical line, a tensile strain

$$= \frac{W\,x}{l} \text{ sec. } \beta$$

The strain on the horizontal members, being repeated at the apex of every triangle, increase from the ends to the centre, where it is a maximum, and the expression for the total strain, on the bottom member at a point distant u struts from the pier;

$$= \frac{W\,x}{l} (n \text{ tan. } a + (n - 1) \text{ tan. } \beta)$$

and the strain on the top member at the same point

$$= \frac{W\,x\,(n - 1)}{l} \text{ (tan. } a + \text{tan. } \beta$$

Let s = the base of one triangle,
D = depth of the girder,
$l - x$ = Y, distance of load from pier A.

then,

$$S = D \text{ (tan. } a + \text{tan. } \beta)$$
$$Y = S\,(-\,n\,1) + D \text{ tan. } a$$
$$\therefore\ \frac{Y}{D} = n \text{ tan. } a + (n - 1) \text{ tan. } \beta$$

substituting this in the equation of equilibrium, in the bottom member we get,

$$\frac{W\,x}{l} \times \frac{Y}{D}$$

which is the expression directly obtained by considering the depth and horizontal member, as a bent lever.

The last expression will also apply to the top member, when

$$Y = (n-1) \text{ (tan. } a + \beta)$$

or y = the distance of the load from the apex f, of the extreme triangle.

Resolution of Strains when the Load is Equally Distributed.

Let w = load per lineal foot then $w\,s$ will represent the load on every summit except, the extreme one, when there will be less, as on the summit f, where the abutment carries half the load on $h\,f$, we find the load

$$= \frac{w}{2} \left(s + \text{D tan. } a \right)$$

for each extreme apex.

As the strains on each side of the centre of an uniformly loaded girder are equal, we shall only consider one half of the girder.

Let $A\,e$ be half the girder.

Applying the above formulæ to the strains produced by each part of the load we find the compression strains to be,

On first strut $a\,b$ $= \frac{w\,s}{2}$ sec. a

On second strut $c\,d$ $= \left(\frac{w\,s}{2} + w\,s\right)$ sec. a

On third strut $= \left(\frac{3 w s}{2} + w s\right)$ sec. a

On $(n - 1)$th strut $= \frac{(2 n - 3) w s}{2}$ sec. a

On nth or last $=$

$$\left\{\frac{(2 n - 3) w s}{2} + \frac{w}{2}\left(s + \text{D tan. } a\right)\right\} \text{ sec. } a$$

$$= \left\{(n - 1) w s + \frac{w \text{ D tan. } d}{2}\right\} \text{ sec. } a$$

From the above it is evident that the strains on the struts increase from the centre of the girder to the ends.

The strain on each tie will be the same as on the corresponding strut with the obvious substitution of sec. β, for sec. a. There are only $(n-1)$ ties, so the last tie corresponds to the $(n-1)$th strut.

The tension on the lower flange from any strut will be found by multiplying the weight acting upon that strut by (tan. a + tan β) thus,

At first strut tension $= \frac{\text{W S}}{2}$ (tan. a + tan. β)

At second „ $= \frac{3 w s}{2}$ (tan a + tan β)

etc. etc. etc. = etc.

And the compression on the upper flange may be similarly found.

The total tension at the centre of the girder

$$= \frac{w s}{2} (\tan a + \tan \beta) (n - 1)^2 + \frac{w \tan. a}{2} \left\{2 (n - 1) s + \text{D tan. } a\right\}$$

as before S = D (tan. a + tan. β), therefore the tension,

$$= \frac{w d}{2} (\tan. a + \tan. \beta)^2 (n - 1)^2 + w \text{ D } (n - 1) \tan. a \; (\tan. a + \tan. \beta) + w d \tan.^2 a = \frac{w \text{ D}}{2} \left\{(\tan. a + \tan. \beta) (n - 1) + \tan. a\right\}^2$$

The compression on the top member will by a similar process be found

$$= \frac{w s}{2} (\tan a + \tan \beta)^2 (n - 1)^2$$

$$= \frac{w \text{ D}}{2} \left\{(\tan. a + \tan. \beta) (n - 1)\right\}^2$$

If there are more than one series of triangles in the girder w will have to be replaced by a smaller value; thus, if there are n series of triangles, we must substitute $\frac{w}{n}$ for w in the above formula.

We shall now proceed to consider the strains on particular forms of braced girders.

TRUSSED GIRDERS.

A D B C (Fig. 18) represents the simplest form of trussed girders, A B

Fig. 18.

is usually a stout timber beam, to which rigidity is added by means of wrought iron tie rods, A C, C B. Let W be a load placed at D, and a the angle which C B makes with the horizon. Then there will be a tensile strain on C B

$$= \frac{\text{W}}{2 \sin. a} = \frac{\text{W}}{2} \text{ cosec. } a$$

In the case of Fig. 19 the tensile strain—

$$= \frac{\text{W}}{2} \text{ cosec. } a$$

The compressive strain on A B in either case

$$= \frac{\text{W}}{2} \text{ cotan. } a$$

The tensile strain on C D

$$= \frac{\text{W}}{2} \text{ cotan. } a$$

If the load is equally distributed, the strains will be, in the case of Fig. 18

Tension on C B $= \frac{\text{W}}{4}$ cosec. a

Compression on A B $= \frac{\text{W}}{4}$ cotan. a

In the case of Fig. 19

w = weight per foot lineal.

x = A B.

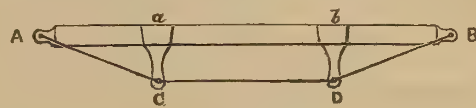


Fig. 19.

Tension on D B $= \frac{w x}{2}$ cosec. a

Tension on C D $= \frac{w x}{2}$ cotan. a

Compression on A B $= \frac{w x}{2}$ cotan. a

There are some other forms of simple trussed girders, but they are mostly derived from those represented above (Figs. 18 and 19.) In small timber bridges these frames are frequently used in an inverted position, when the beams A C, C B,—A C, C D, C B, will become struts, and A B, A B will be ties, which in the case of timber frames is not of much consequence, although it is undesirable to have the struts longer than is absolutely necessary.

PITTAR'S PATENT GIRDERS.

A B (Fig. 20) represents one of the forms of Pittar's Girder.

Let a represent the angle which the bars A e, e b, make with the vertical lines.

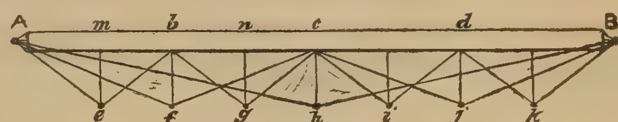


Fig. 20.

It will be the same for the bars b g, g c.

Let B be the angle by A f, f c V, the angle by A h,

w = weight per foot lineal.

Let x = the distance between the uprights, and l = span, then the weight on the first upright

$$= w x.$$

as it carries half the load on A m, the bearing the other half, and also half that on m b. If $l - x = y$, the strain on A e

$$= \frac{w y}{l} \text{ sec. } a$$

and on e b

$$= \frac{w x}{l} \text{ sec. } a$$

both are tensile strains.

The load on n g = w x, and the strain on b g

$$= \frac{w (l - 3 x)}{l} \text{ sec. } a$$

and on c g

$$= \frac{3 w x}{l} \text{ sec. } a$$

both in tension.

The load on b f is found by adding the strains thrown upon it by b e, b g, to w x, it therefore

$$= \frac{w x}{l} + \frac{w l - 3 w x}{l} + w x$$

Let $$W = \frac{w\,x}{l} + \frac{w\,l - 3\,w\,x}{l} + w\,x$$

then the strain on $A\,f$

$$= \frac{W\,(l - 2\,x)}{l} \text{ sec. } a$$

and on $f\,c$

$$= \frac{2\,W\,x}{l} \text{ sec. } a$$

both in tension.

The load on $c\,h = w\,x +$ the load imposed by the bars $f\,c$, $c\,j$, but the strains on each side of the girder being symmetrical, this load

$$= w\,x + \frac{4\,W\,x}{l}$$

If $$W' = w\,x + \frac{4\,W\,x}{l}$$

the strain on A h or h B

$$= \frac{W'}{2}\,y$$

The compressive strains are those produced on A B, by the bars A h h B, the horizontal strains produced by the other inclined bars being neutralised by those from bars inclined in the opposite direction, and also the direct compression on the upright struts $m\,e$, $b\,f$, &c., which is equal to the load upon them.

The compressive strain on A B

$$= \frac{W'}{2} \text{ cotan. } a$$

Warren's Girders.

Warren's girders consist of two horizontal members, and one system of triangles, the triangles are all equilateral, therefore, all the angles made by one part with another $= 60°$, and the angle $a = 30°$, also $B = 30°$. The secant to $30° = 1{\cdot}154$; the tangent to $30° = 0{\cdot}577$.

If we substitute these values in the formulæ we shall have the strains; thus when the load is at the centre, the strain on any bar

$$= \frac{W}{2} \times 1{\cdot}154 = W \times 0{\cdot}577$$

in compression on every bar inclined downwards from the centre to the ends of the girder, and in tension on those inclined the reverse way. The strain thrown upon the horizontal members at every apex

$$= W \times 0{\cdot}577$$

and the strain on the bottom horizontal member, produced by the nth or last strut

$$= \frac{W}{2} \times {\cdot}577$$

the strain on bottom member, at any point

$$= \frac{W}{2} \times 0{\cdot}577\,(2\,n - 1)$$

the compression on the top member at any point

$$= W \times 0{\cdot}577\,(n - 1)$$

To find the strains where the load is equally distributed, we substitute the above values of the secant and tangent in the formulæ.

The tension and compression on the struts and ties will be

$$\begin{aligned} \text{1st strut or tie} &= w\,s \times 0{\cdot}577 \\ \text{2nd} \quad ,, &= 3\,w\,s \times 0{\cdot}577 \\ \text{3rd} \quad ,, &= 5\,w\,s \times 0{\cdot}577 \\ (n-1)\text{th} \quad ,, &= 2\,(n - 3)\,w\,s \times 0{\cdot}577 \\ n\text{th} \quad ,, &= (n-1)\,ws \times 1{\cdot}154 + wd \times 0{\cdot}333. \end{aligned}$$

The total tension at the centre of bottom member, will be

$$= \frac{w\,d}{2}\left\{2\,(n - 1) \times 0{\cdot}577 + 0{\cdot}577\right\}^2$$
$$= wd\,(0{\cdot}666\,n^2 - 0{\cdot}666\,n + 0{\cdot}166).$$

The compression at the centre of top member,

$$= \frac{w\,d}{2}\left\{2\,(n - 1) \times 0{\cdot}577\right\}^2$$
$$= wd\,(0{\cdot}666\,n^2 - 2{\cdot}664\,n + 1{\cdot}332).$$

Lattice Girders.

Although the Warren and trellis girders are usually classed with lattice girders, yet the name is not strictly applicable to them. The lattice girder consists of top and bottom horizontal members, bounding two or more series of triangles, the diagonal bars are rivetted together at their intersections.

To find the strains we use the same formulæ as above, but replacing w by $\frac{w\,n}{n}$, where n represents the number of series of triangles.

Trellis Girders.

This name has been applied to girders of the form shown in (Fig. 21).

Fig. 21.

The bars intersect at an angle of 90°.

The formulæ given will apply if we substitute $\frac{W}{2}$ and $\frac{w}{2}$ for W and w, as there are two series of triangles. The value of the trigonometrical expressions will be:—

$$\begin{aligned} a &= 45° \\ \text{Secant } a &= 1{\cdot}418 \\ \text{Tangent } a &= 1{\cdot}000. \end{aligned}$$

Particular Forms of Lattice Girders.

Many forms of lattice girders have been proposed, each possessing or being supposed to possess some especial advantage, but as yet few varieties have been adopted.

The principle recommendation of the lattice form of girders consist in lightness, cheapness, and being conveniently carried, the last applying particularly to the Warren girders.

A form of girder recently designed, which appears to possess the advantage of economy, is represented in Fig. 22.

Fig. 22.

In this arrangement there is the least strain thrown upon the struts, as they make an angle equal to o, with a vertical line, the secant to that angle being 1.

The greater strain is thrown upon the ties by the above arrangement, but this is of little consequence when compared with the saving on the struts, as the length of the ties makes little or no difference in their strength, whereas the strength of the struts diminishes very rapidly as the length increases (as will be shown in the section on columns), and therefore it is desirable to have the struts as short as possible.

A bridge has been erected on this principle over the Jumna River, with spans of 105ft.

Practical Formulæ.

A general rule to find the strain upon any inclined bar supporting a load may be stated as follows:—Let A B be an inclined bar supporting a weight W; draw a vertical line, A C, representing the load W, and draw B C at right angles to A C, then the strain acting directly on A B

$$= W \times \text{sec.} \angle BAC$$
$$= W \times \frac{A\,B}{A\,C}$$

From this we may obtain simple rules for the calculation of the lattice girder.

Let $W =$ the load,
$n =$ the number of series of triangles in the girder,
$L =$ the span of the girder,
$l =$ the length of a lattice bar,
$d =$ the depth of the girder,
$S =$ the strain on any bar (strut or tie),
$x =$ distance of foot of lattice bar from centre of girder.

When the load is at the centre of the girder,

$$S = \frac{W\,l}{2\,d\,n}$$

When the load is equally distributed over the girder,

$$S = \frac{W\,l\,x}{L\,d\,n}$$

This gives a slight excess of strain on the last lattice bar, but it is sufficiently accurate for practical purposes.

The strain on the horizontal members is in some cases rather less on the top than the bottom member, as will be seen from an inspection of the previous pages. But in common trellis and lattice girders it is the same for both; we therefore give but one expression which will answer all purposes.

The strain on the horizontal members does not continually increase towards the centre of the girder as in plate girders, but receives an addition at every point where two lattice bars join.

To find the strain at any apex

Let S = strain on horizontal member,

T = distance of apex from pier.

The other notations being the same as before.

With the load at the centre of the girder

$$S = \frac{W\,y}{2\,d}$$

With the load equally distributed,

$$S = \frac{W}{2\,L\,d}\left(l\,y - y^2\right)$$

ON THE TRANSFORMATION OF HEAT IN THE PRODUCTION OF MECHANICAL WORK.

By JOSEPH GILL.

From an ingenious speculation, based on the dynamical theory of heat, and the doctrine of the conservation of force, Mr. James Thomson, several years ago, deduced that the freezing point of water is lowered by pressure—a deduction which was subsequently found to be correct by the experiments of his brother Professor W. Thomson. See *Edinburgh Transactions*, vol. xvi.

The substance of Mr. Thomson's reasoning may be briefly stated as follows:—Air at 32°, in the act of being compressed, might give out heat to an indefinitely large mass of water, say a lake, at 32°, the temperature of which would thus be increased by an indefinitely small amount.

The compressed air might expand to its original volume, and give back the whole force expended in compressing it, provided that it recovered as much heat as it parted with during the compression, which it might do by abstracting heat from a small mass of water at 32°, and thus causing part of it to freeze.

By this process power would be neither gained nor lost, and we should merely have transferred heat from the frozen water to the mass of water in the lake. We thus perceive that *water may be frozen by a process solely mechanical, and yet without the final expenditure of any mechanical work.*

By mixing the partially frozen water with the water of the lake we should restore the whole mass to the initial temperature, as the ice, in liquifying at 32°, would take back from the lake as much heat as it parted with in freezing. Things would thus be restored to their initial state, and the above rotation of phenomena might be repeated indefinitely without any final expenditure of mechanical work.

But mechanical work might be obtained from the expansion of the water in the act of freezing, and if in this case we imagine all the other circumstances of the operation to remain the same, we should be assuming the possibility of creating power, therefore perpetual motion, which is allowed to be impossible. Consequently Mr. Thomson supposed that under these circumstances the compressed air would expand with less force than that employed in compressing it, and therefore that it must receive back less heat in expanding than it gave out in being compressed. But this would not be the case if the freezing water retained its initial temperature of 32°, imagining the transfer of temperature to be theoretically perfect; therefore it was deduced that the effect of the pressure applied to the freezing water in order to obtain mechanical work from its expansion must be to lower its temperature, so that the air expanding under these circumstances should have a temperature below 32°.

The experiments of Professor W. Thomson, in which pressure was applied to a strong glass cylinder containing water and fragments of clean ice, proved that the above deduction is correct, as the temperature of freezing water is actually lowered by the application of pressure. The pressure was applied by a screw acting on a piston, as in Oersted's apparatus for compression of water, and the temperature was shown by a sensitive thermometer made for the purpose, and applied so as not to be affected mechanically by the pressure exerted on the water. Professor Thomson says:—"After it was observed that the column of ether in the thermometer stood at about 67°, with reference to the divisions on the tube, a pressure of from 10 to 15 atmospheres was applied by forcing down the piston with the screw. Immediately the column of ether descended very rapidly, and in a very few minutes it was below 61°. The pressure was then suddenly removed, and immediately the column in the thermometer began to rise rapidly. Several times the pressure was again suddenly applied, and again suddenly removed, and the results on the thermometer were most marked. The fact that the freezing point of water is sensibly lowered by a few atmospheres of pressure was thus established beyond a doubt. It is supposed that similar results may be expected for all liquids which expand in freezing; while a reverse effect, or an elevation of the freezing point by an increase of pressure may be expected for all liquids which contract in freezing."

From the above interesting speculation we are led to enquire whether the ice produced under pressure at a temperature below 32° contains less heat than ice formed at 32° under common atmospheric pressure. In the supposed process of freezing water under pressure we observe, on one hand, a loss of power from the cooling of the air below the initial temperature, which prevents its expanding back to the original volume under equal pressure; on the other hand, we obtain power from the expansive force of the water in the act of freezing. If these two opposite amounts of power are equal, then we should suppose that the quantity of heat in the ice produced under extraordinary pressure is the same as that in ice formed under atmospheric pressure, notwithstanding its inferior temperature. For if we suppose that the lower indication of temperature involves a corresponding diminution in the quantity of heat, it would follow that the addition of this colder ice and freezing water to the lake would depress its temperature below the initial point of 32°, and thus, instead of a balance or equilibrium of all the circumstances of the experiment, a certain quantity of ice would be formed in the lake, as the final result of the operation, which would indicate the disappearance of heat equivalent to the latent heat of the water frozen, without any corresponding result to show for it.

The mechanical equivalence of heat, as now taught by the first physicists of England and the Continent, supposes the transfer of the molecular movements of matter to the motions of translations of masses, and *vice versâ*. Thus "Joules' equivalent" results from the supposition that energy applied to cause the agitation of a liquid is transferred to the liquid particles under the form of the molecular motion which we call heat, and which is identical with the molecular condition which is induced in liquids by the direct action of fire.

A weight descending through a given distance is equal to so much mechanical work, and may be made to produce various dynamical effects, as overcoming gravity in raising water—overcoming the attractive force of cohesion in crushing and grinding various substances; overcoming the retarding power of friction in the sliding of bodies over each other with pressure; or in moving the particles of a liquid violently among themselves, and thus producing molecular friction which, overcoming the corpuscular inertia, imparts individual movement to the particles; and each particle retaining its own movement in a rotatory or vibratory sphere, the mass assumes a condition identical with that produced by the transfer of the molecular energy produced chemically by fire. To Dr. Joule is due the merit of determining with comparative precision the correspondence between the thermic and the dynamical phenomena, having ascertained by numerous and accurate experiments with various liquids that the mechanical work resulting from the descent of a weight of one pound through a distance of 772 feet, when thus applied, produces a thermic effect equal to heating one pound of water one degree of Fahrenheit's scale.

Under this view of the subject the "mechanical equivalent" is a convenient means of representing, in a tangible form, the energy corresponding to the more subtile and obscure agency of heat in ponderable matter. The theory is thus in a degree satisfactory, and Professor Rankine justly remarks that it has been the means, in some instances, of anticipating laws, and predicting numerical results, which have since been confirmed by experiment, and in others of suggesting experiments, whereby important laws have been discovered. But the theory is incomplete, and in its present form altogether inadequate to the solution of some of the most important, and at the same time most common problems of practical thermodynamics. Moreover, its application to the phenomena of our heat engines leads to some serious fallacies, which cannot fail to produce a pernicious effect on the real progress of improvement in thermic prime movers, the more grave because apparently sanctioned by the highest scientific authorities. In proof of this assertion it may be sufficient to mention the obvious case of the mechanical energy known to exist in high pressure steam in proportion to its density and temperature, irrespective of the actual quantity of thermometric heat it contains, as shown by transfer to a colder body.

The thermic effects of fire are, apparently, due to gaseous energy, or the rapid motions of particles of matter in enlarged orbits. The mechanical energy due to these molecular movements may be conceived of as the product of the weight and the motion of the particles of matter. Under this superficial view of the phenomena we may imagine a transfer of the mechanical energy of flame to colder bodies, in the shape of molecular motion communicated from a smaller mass of particles, moving with intense rapidity, to a larger mass, which would thereby acquire a certain amount of molecular motion, less or more concentrated in proportion to the quantity of matter acted on by a given amount of heat; and as regards the equivalence of the material molecular movements, the total heat of steam is found to be nearly a constant quantity. Thus 1 cubic foot of steam at five atmospheres' pressure, condensed by contact of cold water, will communicate to the water the same amount of heat as 5 cubic feet of atmospheric pressure steam similarly condensed; and yet the high pressure steam, if allowed to expand to atmospheric tension under a moderated pressure will, in expanding, give out a much larger quantity of mechanical work; and for the difference of the amounts of energy observed to exist in equal weights of steam at different densities, we perceive no equivalent in quantity of thermometric heat in the denser steam.

In saturated vapours temperature is a phenomenon apparently depending on the quantity of particles of matter existing in a given space. If steam be compressed into a smaller volume, its temperature and tension rise in proportion; and on the other hand, expansion of the steam under moderated pressure, or by gradual enlargement of the space which contains it, is accompanied by a corresponding fall of temperature and elastic tension. There seems to be no valid reason to suppose that, theoretically, a single particle of the vapour should alter its state in either of these processes; and the idea of Professors Clausius and Rankine, that steam is condensed simply by the act of producing mechanical work by expansion, cannot be supported, unless on the supposition that the mechanical work produced by the expansion of elastic fluids is simply a result of molecular motion transferred from the expanding fluid to other bodies in the shape of motion of translation of masses, which, I submit, is not satisfactorily supported by practical proof. If heat be communicated to a mass of steam in a close receiver, the steam assumes, for the time, the condition of a gas. If heat be taken away from saturated vapour or steam, part of the vapour is condensed into water, and the remainder continues to occupy the same space, at a temperature corresponding to the diminished number of vapour particles existing in the receiver. Thus the heat required to convert water into steam would seem to be a constant quantity; and there appears to be no practical reason to expect that a given weight of high pressure steam, when directly condensed, should communicate more thermometric heat to the condensing water than would be given out by the condensation of an equal weight of low pressure steam. It is certain, nevertheless, that high pressure steam contains more mechanical energy than steam of low pressure, weight for weight, and *we are compelled to look for the source of this excess of energy elsewhere than in the mere molecular result of matter and motion supposed to constitute the steam, and calculated by the usual laws of mechanics.*

In an essay on the thermodynamics of elastic fluids, recently published, I endeavoured to show that in the generation of vapours and the expansion of elastic fluids in general, mechanical work is performed by conversion of sensible heat into latent, as the apparent thermic phenomenon, without any theoretical loss or diminution of the thermometric heat contained in the fluids. Thus, as stated above, high pressure steam in expanding to lower pressures under a *moderated* resistance produces mechanical work, and yet it is supposed that the expanded steam contains, theoretically, the same, or nearly the same initial quantity of heat, only altered in quality or condition by a corresponding change from the sensible to the latent state. Moreover, the results of numerous experiments on a large scale have given ample reason to conclude that all the heat transmitted from the boiler should be found, theoretically, in the condenser water of low pressure engines, only diffused and of lower temperature. To elucidate this latter position it may be requisite to explain that, in the case of low pressure steam working without expansion, all the power of the engine is generated in the forming of the steam, by conversion of sensible heat into latent; and the mechanical work is obtained as its indirect result by condensation, which may be considered as a process of transfer, or transformation of work already performed in a different shape. This theory of the transformation of heat, as it may be called, if we continue to use the current unsatisfactory terms of *latent* and *sensible* as applied to heat, is obviously applicable to all cases of elastic fluids in which compression causes a change of latent heat into sensible, and expansion is accompanied by a change of sensible heat into latent. It seems to be equally applicable to solids which expand by heat, as it is supposed that a solid mass (of metal for instance), the expansion of which should be entirely prevented by external coercive pressure, or rather statical resistance, would acquire a given increase of temperature with a smaller amount of heat than would be required to produce the same thermometric indication under free expansion of the mass. And it is supposed, moreover, that the expansion of such heated mass *under moderated pressure* in the production of mechanical work must be accompanied by a fall of temperature, or a change of sensible heat into latent, the whole quantity of heat in possession remaining the same after the expansion, only at a lower temperature.

Heat and cold produce effects generally similar to those of compression and expansion, by increasing and diminishing tension under equal volumes, or augmenting or decreasing volume under constant pressure. But there are many known instances of a departure from the general law of matter, which connects condensation or contraction of volume with depression of temperature, of which water is a remarkable example, as at temperatures between $39\frac{1}{2}°$, or the point of greatest density, and the freezing point, an abstraction of heat with corresponding fall of temperature produces expansion of volume, which is still more marked in the act of freezing, when a large amount of heat, and varied and extensive as its effects are perceived in the economy of creation, I think there can be little doubt that what are called *sensible heat* and *latent heat* in common matter are only indications of molecular states of existence or arrangement, being respectively correlative with *statical force* and *dynamical force*, and not only equivalent thereto, but actually constituting the phenomena attending the molecular states or conditions in question, as seems evident in elastic fluids; and, taking the facts as they are observed in the natural constitution of matter, it will be found that the same thermodynamical law of transformation of heat in the production of mechanical work, which was above shown to be applicable to solids and elastic fluids, appears to be also applicable to the curious phenomena of the depression of the freezing point of water by pressure, as bodies in the *exceptional state*, to which allusion has been made, seem to be governed by the same laws, but with an inverted order of action.

From the train of reasoning above pursued, we supposed that ice produced under extraordinary pressure should contain the same quantity of heat as ice formed under the ordinary circumstances of atmospheric pressure, notwithstanding the lower temperature which experiment shows it to possess. Let us inquire how the proposed doctrine of transformation of heat will apply to the phenomena. When water becomes ice under common atmospheric pressure with free expansion, and therefore without production of available mechanical work, the process shows merely the change of the latent heat of the liquid, water, into sensible heat in the act of being thrown out of combination by the forming of the solid, ice, the specific heat of which is so much less than that of water, and therefore so much heat must be rejected by the mere change of state. This is analagous to the conversion of steam into water. The total heat of steam is supposed to be nearly constant, irrespective of its density and temperature, and all the heat of conversion of each particle must be abstracted before it can change back into the liquid state. Upon this point there cannot be much diversity of opinion; but the query presents itself, what becomes of the heat so abstracted under the various circumstances which may accompany the process?

The current theory of the mechanical equivalence of heat assumes that it is all transferred to other matter as common heat, if no mechanical work is performed by the operation; but that when mechanical work is so produced, a portion of the heat equivalent to that work actually disappears, being directly converted into the work, and only the remaining portion is transferred to the matter used as a refrigerating medium in the process.

The proposed theory of the transformation of heat would indicate that in all cases the total heat of conversion of the steam is transferred to the matter used as a cooling medium in the process, and that when mechanical work is produced, it results from a conversion of energy into available work, the energy existing in the steam as a consequence, or correlative condition of density, pressure, and temperature, all of which indications must undergo depression in the work-producing process of *moderated expansion*, which is identical or co-existent with the change of sensible heat into latent. In the case of free, tumultuous expansion, where no external available mechanical work is performed, the density and pressure of the steam are depressed, as also its temperature, but in a lesser degree than in the former case, the actual quantity of heat in possession *increasing* by an amount equivalent to the molecular work produced internally by the expansion of the fluid.

In the case of water within the range of temperature at which it shows the exceptional phenomena of expansion from cold or deprivation of heat, instead of the usual contraction of volume, an inverse order of effects might be expected also in the other circumstances which affect it while in this exceptional condition. Therefore as compression generally causes a change of latent heat into sensible, and expansion when producing mechanical work is attended by a change of sensible heat into latent as the inseparable counterparts of the phenomena, opposite results might be expected from equal thermic conditions in water *in the exceptional state* under which we are viewing it. Thus the compression of water within the range of temperature corresponding to the supposed inverse order of thermodynamical effects of which we are treating, may produce a change of sensible heat into latent, with the consequent disappearance of thermometric indication of heat, as apparently proved by Professor Thomson's experiments. Water at 32°, under common atmospheric pressure, when containing the smallest fragment of ice, cannot be cooled below this degree by abstracting any portion of its heat, as the result would be the immediate formation of ice corresponding to the amount of heat removed from the liquid, the temperature of the ice and the remaining water continuing constant at 32°. But it is proved that water under extraordinary pressure may retain its liquid condition in contact with ice at temperatures below 32°; and this result appears to be due to a change of sensible heat into latent in the liquid under such circumstances, so that it *appears colder*, while the total quantity of thermometric heat in the mass remains unaltered; in other words, its specific heat or capacity for heat becomes greater as a result of pressure.

These considerations would seem to support the idea that each change of matter from a lower to a higher state of existence is effected only by a *saturation of heat* corresponding to a fixed quantity for each substance, generally irrespective of the circumstances which may otherwise affect it during the change of state. The recent experiments of Regnault, Joule, and Fairbairn lead to the conclusion that the total heat of steam is not a constant quantity, and in the absense of conclusive results from experiments of my own on this subject I would merely remark that the results I have so far obtained leave some reason to believe that the question is not yet definitely settled, and that facts, as well as analogy, are still found to give weight to the deduction of Watt and his contemporaries, that the heat of steam is a constant quantity.

INSTITUTION OF ENGINEERS IN SCOTLAND.

February 5th, 1862.

ON THE MECHANICAL AND ECONOMICAL ADVANTAGES AND DISADVANTAGES OF SURFACE CONDENSATION.

By Mr. John Frederick Spencer.

(*Illustrated by plate* 210.)

Two papers on Surface Condensation have been given to the engineering world during the past twelve months—the first by Mr. Davison, in this Institution; and the second by Mr. Louch, to the Society of Engineers in London.

The rapid progress and introduction of the system of surface condensation during the past eighteen months has, however, been so great, that there appears to be a general desire to receive further information on the subject, and the author of the present paper most willingly acceded to the request for the results of his experience. It is his sincere wish to treat the subject of surface condensation generally, and without reference to any supposed or actual superiority, of the plans of A, B, or C, as it is considered the discussion will give the needful opportunity for the explanation of new or improved plans. When it is considered that within the past two years upwards of a dozen steamships have been fitted on the Clyde with surface condensers, and some of them of large power, this Institution may justly claim a precedence in the receipt of any additional information on the subject of surface condensation.

Mr. Hall's surface condensers, twenty-four years ago, were chiefly made and fitted in the south; and at the present time engines of large power are being fitted with surface condensers by Messrs. Penn, Maudslay, and Humphreys. The papers previously referred to have described most of the plans af surface condensers now before the public, and it is assumed in the present case that the members of the Institution are well acquainted with the distinguishing features of surface condensers, and do not require this information to be repeated. *The* question to be decided is, whether surface condensation has sufficient advantages to warrant its general introduction and adoption in preference to condensation by injection. The evils to be remedied by surface condensation may be briefly described as the loss of heat from blowing out in *marine* boilers, and the deposit of scale in *all* boilers. The chief advantages may be stated as the removal of the chief difficulty in the way of using higher-pressure steam; being able to use the foulest water for condensing purposes, without risk of injury to the boiler, and the saving of repairs rendered necessary by such deposit.

In accordance with the title of this paper, it is proposed, as fully as possible, to consider in detail the most important advantages and disadvantages of surface condensers, as proved by actual experience; for it is believed that all partial statements must sooner or later be disproved by an extended experience, and that to insure success we must have "the truth, the whole truth, and nothing but the truth."

The mechanical advantages to be derived by the adoption of surface condensation are:—

I. Freedom from all unsafe deposits on those internal parts of boilers exposed to severe heat.

II. The use of boilers of improved construction, and suitable for steam of higher pressure.

III. The use of the foulest water for condensing purposes, without incurring any risk of injury to the engines or boilers.

IV. Increased regularity of feed to the boilers, and consequently less risk of injury to them from a deficiency of water.

V. Increased uniformity of load on the air-pump, rendering it unnecessary for the engineer in charge to reduce the injection or condensing water in heavy weather.

It is believed those five advantages include all of importance as affecting safety or convenience, so far as the past and present experience can guide us. Each of them will be referred to in detail.

I. *Freedom from unsafe deposit, &c.*—This is a natural result of the separation of the condensing water from the condensed steam, and what is now required is actual results from the longest experience. This past Christmas a steamer fitted in August, 1857, with a new boiler and surface condenser, was carefully examined, and a report made on its actual condition. This report will be found in another part of the paper. Here it is only necessary to state that there has never been any necessity to scale the interior plates, as is usual with salt-water boilers. In other instances of shorter experience, the same freedom from inconvenient scale or deposit has existed.

II. *The use of higher pressure, &c.*—Of this there cannot be a doubt, as the general introduction of high-pressure steam into sea-going steamers is prevented chiefly by the necessity of providing for the removal of scale and incrustation, and thus rendering it almost impossible to stay the boilers for a high pressure. All that is required to give an onward movement to high-pressure marine engines, is an increased experience of, and confidence in the preservation and durability of the boilers. Even already, surface condensation and high-pressure steam, of from 40 to 120 lbs. pressure, have gone hand in hand across the Atlantic and up the Mediterranean.

III. *The use of foul water for condensing, &c.*—This is a real vantage ground, and one of the most hopeful features of surface condensation. Engineers are well aware that even pure *land* water is almost unknown; that many of our largest manufacturing works are situated near the sea, or where the most serious effects are produced on the boilers from impure feed-water; that boiler incrustation is a constant source of complaint and reference at the meetings of the Manchester Steam Boiler Association; and that many of the rivers in India and abroad are little better than liquid mud or sand. These facts, with numberless others to the same effect, are well known to practical engineers. Surface condensation steps in, and, like the magician's wand of old, converts impurity into purity, or enables the engineer to do so, which is the same thing in effect. At the present time the author is fitting seven surface condensers of 650 total horses power to land engines, where the river water is impure. The condensers are being made in consequence of the success of one that has been working for the past twelve months.

IV. *Regularity of the feed-water.*—With the marine engines at sea, working with injection condensers, it requires constant and anxious attention to maintain a proper balance between the proper quantity fed into the boiler, and that blown out—and many a good boiler has been ruined by neglect on this point. With surface condensers, except in cases of priming, the necessity for blowing out scarcely exists, and the regularity of the feed is a source of increased safety and great relief to the engineer in charge. On several occasions the author has run at sea from twelve to eighteen hours without making any alteration in the feed-valve arrangements.

V. *Increased uniformity of load on air-pump.*—This advantage can only be thoroughly appreciated in heavy weather at sea. With an injection condenser in a sea-way, unless sudden changes in the speed of the engines are met by corresponding changes in the amount of condensing water supplied, there is a danger of the air pumps being overloaded, and the giving way of the discharge valve is often the result, endangering the safety of the ship. With surface condensers it is quite unnecessary to stand by, to regulate the supply of condensing water in heavy weather; and in a strong sea in the Atlantic, the author has known days pass without the water regulating-valve being touched.

Those who are practically acquainted with the working of steam-engines, especially marine engines, can appreciate the value of the advantages referred to as incidental to the use of surface condensers; and it must be admitted that the most favourable view has not been taken; for, among other advantages not named, may be mentioned that of the reduced size of air-pump. This has not been referred to at present, for two reasons—first, the reduction in size is partly counterbalanced by the addition of the circulating pump; and secondly, the matter is referred to in a subsequent part of the paper.

It is now proposed to consider the mechanical disadvantges incidental to the adoption of surface condensation. They may be divided under five heads:—

I. The necessity for an additional pump, pumps, or other machinery for circulating the condensing water.

II. The additional space required for the surface condenser, and also in some cases for the condensing-water pump or machinery.

III. The alleged tendency to corrosion in the boiler when working with water supplied from surface condensers.

IV. The complication arising from a multiplicity of tubes or sheets forming the surface condensers.

V. The increased liability to leakage from the number of tubes or other joints in the condensers.

I. *Additional pumps, &c.*—It cannot be denied that whatever plan of circulating the condensing water may be adopted (when a high vacuum is required), it is and must be additional to the air and feed pumps. There is, however, some compensation in this case, inasmuch as it has been proved, by indicator diagrams, that the total load on the air and circulating pumps is less than that on the injection air-pump, allowance being made for the difference in the capacity of the two air pumps; and experience has proved that, with surface condensation, the same vacuum can be obtained with one half the capacity of air-pump required with an injection condenser.

In the last discussion on Mr. Davison's paper the author gave three cases of comparison, showing the vacuum actually obtained, and the capacity of air pumps on the two systems. These being well-certified cases, are repeated here in illustration of the preceding remarks.

S.-ship.	H. P.	Injection.		Surface.	
		Air-pump. (Per minute.)	Vacuum.	Air-pump.	Vacuum.
		Cubic feet.	Inches.	Cubic feet.	Inches.
No. 1 ...	50	70	23	45	24·5
No. 2 ...	100	350	23	200	24·5
No. 3 ...	400	1100	25	500	27·5

As a further illustration, may be mentioned the 500-horses-power engines of H.M. frigate *Arethusa*, fitted by Mr. Penn with the author's plan of surface condensers. On trial with air-pumps about one half the usual capacity for engines of equal power, a vacuum of 26·5 inches was obtained.

In the only case where the author had an opportunity of correct comparison with the same engines, it was found that with one inch and half better vacuum, the load on the air and circulating pumps was about ten per cent. less than that in the injection air-pumps.

All these facts, resulting from actual experience, being duly considered, the disadvantage of the additional pump is reduced to a minimum, and confined to its being simply an additional piece of machinery involving no increased duty.

II. *Additional space occupied.*—In many cases the additional space required in the engine-room for the surface condenser and pumps has militated considerably against the system. A very slight consideration, however, will somewhat paradoxically change this disadvantage into an advantage. It is quite true that more space is required for the surface condenser on board ship; but what benefits are derived from its use? Taking the lowest estimate, a saving of 15 per cent. of fuel is realized. Take a case in actual practice—injection engines requiring 45 tons per day for a ten day's voyage, making a total stowage of 18,000 cubic feet. Now, attach to these engines surface condensers occupying an additional space say of 300 cubic feet, and we will make no deduction for the space occupied by the injection condenser—the saving of space for the voyage will be 15 per cent. of 18,000 cubic feet, equal to 2700 cubic feet. It now becomes simply a credit and debit account: credit surface condensation with 2700 cubic feet of space saved, and debit surface condensation with 300 cubic feet occupied, we have then a balance of 2400 cubic feet in favour of surface condensation. Strictly speaking, in many cases the balance will be even more favourable. It is evident, therefore, the alleged disadvantage becomes an important element of economy of space when the whole question is fairly considered. Credit will also frequently have to be given for reduced diameter of cylinders and bulk of boilers. With the present limited experience of the actual economy resulting from surface condensation alone, and the well-known facility with which steamship proprieters claim all improvements, and, at the same time, insist on having as big engines and boilers as ever, the author has preferred abstaining from raising hopes that may not be realized for many years.

III. *The alleged tendency to corrosion.*—This is undoubtedly the most serious charge that can be brought against the system of surface condensation; and, if proved to any serious extent, will render its success exceedingly doubtful. That there is an element of truth in this most serious objection to the fresh-water system, experience has proved. Cases have occurred, both in America and in this country, where boilers supplied with water from surface condensers have corroded much more rapidly than boilers working with salt water. In making this admission, however, the advocates of surface condensation are fully aware that this corrosion has not occurred in all cases; and not only so, it is also believed that with the present knowledge on the subject such corrosion might have been prevented. In the cases of corrosion that have come under the personal observation of the writer, its appearance has been that of a honey-combed action on the plates and tubes, of some deleterious substance held in solution by the water, and deposited in showers. These circumstances have chiefly given rise to the opinion that portions of the metal from the condenser tubes, and steam and feed pipes, have been carried into the boilers, and gradually accumulated in sufficient quantities to act on the iron plates and tubes of the boilers. But as the galvanic or chemical action between copper and wrought-iron is generally due to the presence of salt in the water, and as no serious injury arises from the presence of brass tubes in boilers, there is some difficulty in thus accounting for the corrosion, more especially as it has been found most severe when the water has been the purest. There is much difficulty in explaining the true cause of the corrosion, but the causes alleged will be stated, with a few remarks on each, and any experience of the author's that bears on the subject. All those who are interested in the success of surface condensation are appealed to, to contribute their experience on this most important question. If there exists an evil that cannot be remedied, let it be known as such. The true spirit of engineering seeks to benefit mankind, and not to perpetuate a system that is no improvement on its predecessor.

There are two principal causes alleged as producing corrosion in distilled-water boilers:—

1. A softening effect of pure soft water, without any mineral hardness in it.

In support of this view, cases have repeatedly occurred where wrought-iron boilers fed with soft land water have been destroyed in six months. Cases have occurred in the neighbourhood of Newcastle-on-Tyne. The only remedy for this would be chemically to counteract this injurious action, or at sea to mix with the pure water a portion of sea-water.

2. Chemical or galvanic action from the presence of copper in the boiler, conveyed there in the water, or grease from the steam and feed pipes and condenser tubes.

From careful observation, the author has formed his own opinion on the cause of corrosion, and is regulating his practice in accordance with it. He thinks that, although in some cases the excessive purity of water may be hurtful, the chief cause of corrosion is the want of *change* in the water, thus allowing of an accumulation of particles of copper from the condenser tubes, and chiefly from the *steam* and *feed* pipes, until the solution is sufficiently strong to affect the iron. The mixture of a small portion of salt water, sufficient to produce a gradual change of water, has been found to prevent any serious corrosion, as well as to check it when it has commenced. No appreciable loss of economy of fuel will be caused by this plan, and it relieves the engineer from any necessity of supplying the waste of pure water occurring in surface condensation, by a reserve on board. It may also be found desirable to tin the steam side of the condensing surface, as well as to substitute iron for copper steam and feed pipes.

Having thus glanced at the gloomy side of this barrier to the general adoption of surface condensation, the inquiry is made whether any boilers have met a violent death, or been consumed in say from twelve to eighteen months, or even two years? To this inquiry we may cheerfully and decidedly reply in the negative. In America, it is said, some boilers have died very young from surface condensation; but as the informants have not supplied date of birth or death, symptoms of illness or appearance of the body after death, nor given us the results of any post-mortem examination, we shall act wisely in waiting for more accurate information. In England present experience in boilers fed with water from surface condensers is very limited and short-lived. Speaking generally, there is no authenticated case of a boiler worked with distilled water that has suffered more, permanently, from corrosion than boilers fed with sea-water, whilst there are instances of their suffering much less from corrosion than salt-water boilers.

As stated previously, a small steamer was fitted with a new boiler and a surface condenser in August, 1857, and the following is a correct report of the state of this boiler at Christmas just past:—

Newhaven, Sussex 18*th January*, 1862.

I.S. steamer *Alar*, 50 H.P., fitted with a new boiler and Spencer's surface condenser in August, 1857. Distance gleaned to this date, 100,000 knots; steam pressure, 40lbs.; waste made up with sea-water.

Condition of boiler examined this day by the undersigned :—

External cylindrical shell in sound and efficient condition externally and internally.

Furnaces, externally and internally, in good condition, and apparently equal to new.

Flame chamber, top sides and back in good condition, and no signs of wasting. A small patch, 8 inches by 3, wanting at bottom, where plate is thinned by a leaky rivet.

Tube plates, sound, and in good condition; quite equal to that of the external shells.

Tubes, 148 iron tubes, $3\frac{1}{4}$ inches in diameter; not feruled; 8 tubes have been renewed, and the remainder will require renewal this year.

Stays.—The long shell stays, angle iron, &c., as far as can be seen, do not require renewal, many of them being in a perfect condition. The two upper rows of screwed stays at the back of the flame-box were renewed in April, 1861. A few of the screwed stays in furnace-water-spaces are wasted, and require renewal; but it is believed the waste has been caused chiefly, if not entirely, by the wash of the water and grit when the ship rolls. The remainder of the screwed stays are in good condition.

Uptake.—As far as can be ascertained, the plates and rivets are in good condition, and not wasted.

(Signed) EDWARD FOWLER, *Superintendent.*
J. JOHNSON, *Chief Engineer.*

In order that the above report may be understood, the boiler is represented in figs. 4 and 5, Plate 210.

The following is a report on the condition of a 100 H.P. boiler attached to a pair of the author's surface-condensing marine engines. The boiler has been twelve months working :—

Boiler—apparently as good as new. There was a very thin scale of salt on the furnace crowns and tubes. The flat part of uptake was covered with a deposit of tallow and mud to the thickness of two inches. The uptake does not appear to have suffered any damage by the deposit thereon. A few of the top stays are a little corroded. That, I consider, is due to the wash.

(Signed) WILLIAM DIXON, *Manager to Messrs. R. & W. Hawthorn.*
December 26, 1861.

To these reports is added a third, of four London-made boilers, working with injection condensers, and having steam up on an average seven hours a day for four days in each week.

Report on the condition of four boilers started at Christmas, 1856—25lbs. steam, and distance run under steam, 65,000 knots :—

NEWHAVEN, *January*, 1862.

Uptakes renewed in the autumn of 1859; also the stays and angle irons at uptake end; top shell of boilers partly replated.

Christmas, 1861.—Uptakes thickened with $\frac{1}{4}$-inch plate, new angle iron, and stay ends at uptake; new bottoms to shell; several patches in furnace-crowns; 250 screwed stays renewed in each boiler; 240 brass tubes to be taken out of each boiler to scale the tube plates and tubes; these tubes pieced up and replaced.

(Signed) EDWARD FOWLER, *Superintendent.*

These reports are trustworthy, and are not in any way "got up" to support surface condensation. Two of the *Alar's* tubes are produced for the inspection of the members.

One conclusion is certain, that whilst there is no occasion for alarm on this subject of corrosion, practical men cannot be expected to endorse many of the extreme statements published in favour of surface condensation; such as these—that land boilers last seven times as long as marine, and that boilers worked with distilled water last three times as long as those working with salt water. Such statements only retard the progress all so earnestly wish for. Even supposing that boilers supplied with water from surface condensers only last the *same* time as those fed from injection condensers, the advantages of the surface-condensing system are overpowering.

IV. *The disadvantage of complication.*—On this head little can be said. It is a decided disadvantage, although practically it will be found of little importance when compared with the credit side of the account. The introduction of the multitubular boiler was objectionable on the same grounds; but, nevertheless, it has been found that the advantages greatly predominate.

V. *The increased liability to leakage in the condenser.*—This disadvantage is one that can only be rightly valued from a more extended experience. If, after a number of years, it is found that surface condensers are as tight as when new, the disadvantage arising from a multiplicity of joints is only imaginary. At present it may be conceded as a practical objection. There is much reason to believe that a surface condenser, made and jointed on a correct principle, will become *less* liable to leak, as it gets older. In the opinion of the author, facilities for examination and repair, together with extreme simplicity and fewness of joints, are the *desiderata* for all surface condensers. Practical experience will correct many of the mistakes in the plans of surface condensers now being made, and theoretical perfection must be made to give place to practical simplicity. In saying this, the author does not for one moment presume to intimate that *he* has solved the problem; on the contrary, his experience leads him to seek rather than to offer advice.

It is now proposed to consider the economical advantages and disadvantages of surface condensation.

Economical Advantages.

1. *The saving of the fuel wasted in blowing out* a *sufficient quantity of heated water and steam to avoid unsafe deposit.*

The amount of this saving in actual practice ranges from 15 to 25 per cent., and is an advantage in sea-going steamships that cannot be disputed; nor has it, in fact, ever seriously been so. That the amount of this saving cannot be correctly estimated by calculation is undoubted; and the author, from much consideration and observation, is confirmed in his opinion previously expressed to this Institution, that in blowing out from, or just under the surface of the water in the boiler (the usual practice), much additional waste of heat occurs from the mixture of the steam and its latent heat with the water that is discharged by the scum-pipe.

2. *The introduction of higher-pressure steam, and consequently the economy resulting from increased expansion.*

It is impossible at present to say to what extent the introduction of surface condensation will *immediately* affect the increase of the working pressure. In all probability no general move will be made in this direction, until it is ascertained what reliance can be placed on the durability of the boilers worked with fresh or distilled water. Those engineers who have so perseveringly striven to introduce high-pressure steam, with its attendant economy, deserve the best wishes of all who are earnest in steam-engine improvement; and it is matter of sincere congratulation that they will now have the powerful aid of surface condensation. Their success, or rather the success of the system they advocate, is only a question of time.

3. *The saving of labour in cleaning boilers, as well as the saving of repairs and renewals,*

Of the saving of labour in cleaning boilers supplied from surface condensers, there can be no doubt. The saving in repairs and renewals can only be credited when experience has proved its value.

4. *The saving of fuel arising from keeping the boilers free from any thick scale or incrustation.*

It is well known with ordinary injection engines the supply of steam gradually lessens each year, whilst a larger amount of fuel is consumed to obtain the diminished supply. This waste and loss is entirely obviated with surface condensation, as the amount of scale formed, with a considerable mixture of salt water, is quite insufficient to cause any appreciable loss of steam or waste of coal.

These four enumerated sources of economy in surface condensation are the most prominent and evident among many other incidental ones. Their exact monetary value cannot be given.

It remains now only specifically to allude to those disadvantages of surface condensation that tend to increase the cost of steam power.

1. *An increased first cost of machinery, varying from* 10 *to* 20 *per cent.*

It has been asserted that the same amount of power will cost less with surface condensers than with the ordinary system, and for the reason that half the boiler power can be saved; and this statement is further supported by reference to a steamer, in which it is said the same duty is realized from half the usual boiler power. The writer of that statement is most decidedly deceiving himself. Steam engines fitted with surface condensers cannot be made for the same money as those fitted with injection condensers. The *average* saving in steam or heat by surface condensation cannot be fairly taken at more than 20 per cent. or one-fifth, and it follows, therefore, that only one-fifth of the boiler power can be saved, and this amount of saving will only represent one-third or one-half of the extra cost of the surface condensers. That steam engines fitted with surface condensers, and other improvements in machinery and boilers tending to economy of fuel, may *ultimately* be profitably made, per indicated H.P., at a price as low as, or even lower than that now charged, is not only possible, but highly probable.

At the same time, every steam engineer is aware there are circumstances connected with the introduction of improvements for economizing fuel that tend to increase the first cost of steam power, the user, nevertheless, receiving a larger return on his outlay by the reduced consumption of fuel.

2. *The increased cost of repairs to the additional machinery and the condenser.*

This increased cost will be slight, and is not worthy of serious consideration.

Having thus briefly stated the advantages and disadvantages, mechanical and economical, incidental to the adoption of surface condensation, it only remains to touch on one or two points that have escaped notice, and then, in conclusion, to sum up the whole.

How much surface is required per indicated horse-power is a question often asked, and the merits of various plans of condensers are decided by the amount of surface each requires per indicated horse-power, without any regard to the degrees of expansion or the mode of using the steam. It is quite useless to compare the surfaces of a condenser receiving steam expanded fourteen or sixteen times with that of one where the steam is expanded twice or thrice; and, for the same reason, the bulk or space occupied by condensers cannot be compared without making due allowance for the mode of working the engines. For instance, with steam expanded ten times, one-third less condensing surface (about) should be required per indicated horse-power than when expanding once. The duty of the condenser is to be decided only by the *weight* of steam condensed per interval of time.

Furthermore, as the efficiency of a surface condenser bears a proportion to the difference of temperatures of the condensing and condensed water, in all cases more water is required to condense an equal weight of steam by surface than by injection. In a surface condenser, if a small surface is used, the discharging temperature of the condensing water must be low, and the quantity large. With a large surface the reverse will be the case. But, practically, it is impossible to assimilate the temperatures of the discharged condensing water and that of the condensed steam, as is the case in an injection condenser.

In summing up, it will be stated what condensing surface the author has found effective in cases where the steam is cut off at one-third, equivalent to expanding twice, and where either steam jackets or superheaters are adopted.

A series of indicator diagrams, taken at sea by the author, from the air and cold water pumps of three different pairs of engines* fitted with surface condensers, are represented in Plate 210, Figs. 1, 2, and 3.

The conclusions intended to be drawn from the preceeding observations are—

1. That a positive and decided saving of fuel, varying from 15 to 25 per cent., may in all cases be realized by the substitution of surface for injection condensers in sea-going steamers.

2. That in all cases where water is foul or impure, and can be obtained in sufficient quantity, surface condensers ought to be adopted.

3. That present experience does not warrant the durability of boilers, worked with surface condensers, to exceed that of those fed with salt or impure water by more than 50 per cent.

4. That all serious corrosive action in boilers worked with surface condensers can be prevented by a gradual but sufficient change of water without seriously affecting the saving of fuel.

5. That at present surface condensers add from 10 to 20 per cent. to the first cost of marine steam engines.

6. That one-half the capacity of air-pump is sufficient to obtain any given vacuum when surface condensers are substituted for injection condensers.

7. That with an expansion of twice and superheated steam or steam jackets, one-half the boiler surface is ample for the condensing surface.

8. That in all cases a larger amount of condensing water is required for surface than for injection condensers.

9. That when surface condensers are adopted the boiler power may be safely reduced one-fifth, without any loss of indicated power.

* In the Table given in this Plate, explanatory of these diagrams, C.W.P. refers to the Condensing Water Pump; A.P., Air Pump; A, Atmospheric Line.

INSTITUTION OF NAVAL ARCHITECTS.

ON THE MANUFACTURE OF ARMOUR PLATES,

By CAPTAIN J. FORD.

That the British Navy must be re-constructed by the substitution of armour-plated ships of war for its old wooden walls, is now universally admitted.

It becomes, therefore, a most important question, what is the best method of manufacturing the armour plates?

This subject was first brought under the consideration of the writer when the Thames Iron Works Company received the order for building the *Warrior*, and it became a question with the firm whether they should erect steam hammers for the purpose of forging, or increase the power of their mills for rolling the plates.

At that period, after careful consideration, the conclusion was adopted, that the plan of hammering would produce the best results, and subsequent experience has, in the opinion of the writer, fully borne out that view.

That the best material for these plates is iron, appears to be established by all the experiments which have been made; many trials of plates of homogeneous metal or steel of various descriptions have shown, that although thin steel plates have resisted shot better than iron ones, when the thickness was increased beyond $\frac{3}{4}$-inch, there was visible inferiority, and the thicker plates altogether failed.

Two qualities in the iron appear to be of prime necessity—toughness and solidity. If the iron is hard and brittle, it is easily cracked and broken by the shot; if of unsound, either from blisters or lamination arising from imperfect welding, the power of resistance is proportionately diminished. It has been conclusively proved that any given thickness of iron, if composed of layers of thin plates, has very little resisting power in comparison with the same thickness of solid plate, and a plate apparently solid, but imperfectly welded, exhibits the same weakness.

The process of rolling plates $4\frac{1}{2}$ inches thick has been described by the head of the eminent firm of Messrs. Brown and Co., of Sheffield, in a paper read by him at the Institution of Mechanical Engineers, Birmingham, as follows:—

Bars 12 inches broad, 1 inch thick, are first rolled; five of these are then piled and rolled into a rough slab; two of these slabs are rolled into a plate $1\frac{1}{4}$ inch thick; four of these plates are then piled and rolled into a plate $2\frac{1}{2}$ inches thick; and finally four of these $2\frac{1}{2}$-inch plates are piled and rolled into the finished plate.

The hammered plates manufactured at the Thames Iron Works are made in the following manner:—Scrap iron of the best description is carefully selected and cleaned, piled, hammered into a bloom, and then rolled into bars 6 inches broad, and 1 inch thick; these bars are cut up, piled, and again hammered into a slab; several of these slabs are put together, heated and hammered to the form required, and this process being repeated, the plate goes on gradually increasing to the length required.

In the manufacture of the best hammered plates, there is no mystery: it depends simply on the selection of the best material, and the employment of the most skilled and careful workmanship.

The writer confidently believes that scrap iron, rolled and hammered as before described, is decidedly the best material, and superior to any description of the puddled iron from which all the rolled plates are understood to be made. That the toughness of iron is dependent greatly upon the amount of working it undergoes, cannot be doubted. This working has already been given to a great extent to scrap iron, and the process of rolling it into the 6-inch bars, which are the raw material of the future plate, gives it a degree of toughness and fibre which it appears to retain through all the subsequent heating and hammering.

The tendency of hammering to harden does not take away this toughness, and the process of annealing restores much of what is lost. Numerous experiments on single plates which have been fired at, and close observation in the drilling, planing, and bending of the large quantities of plates which have been hammered in this manner, have shown that the brittleness which has been attributed to hammered iron is entirely avoided, and that the toughness of the iron is superior to that of the best rolled plates which have hitherto been produced. Solidity and freedom from blisters or lamination is unquestionably more certain in the hammering process; and when it is considered that to produce a rolled plate 160 thicknesses of iron must be perfectly welded at every point throughout the finished plate, under penalty of there being lamination, the frequent occurrence of this evil would seem to be inevitable; the presence of dirt between any two layers, or the failure to reach a welding heat in any part of the centre of the large masses which have to be dealt with, being certain to produce this fatal result.

It must also be remembered that, as the hammered plate is gradually built up of the slabs before described, a comparatively small portion of the mass requires to be placed in the furnace and heated at one time, while in the rolled plate the final pile, 10 inches in thickness, and weighing six or seven tons, must be brought to a welding heat at once, and the operation of rolling completed before this heat is lost. To obtain this heat throughout the mass without burning the edges most exposed to the fire can hardly be counted upon as a uniform result, and when this has been accomplished, any delay in dragging it from the furnace, getting it to the rolls, forcing it between them, and completing the rolling process, will spoil it, and the loss, even of a few moments, may be fatal to the success of the operation.

These difficulties, of course, increase with the thickness and weight of the plates; the foregoing observations are made with reference to plates $4\frac{1}{2}$ inches thick, such as are on the sides of the *Warrior* and her companions; but when, as in the case of the *Minotaur* and her sister ships now building, the thickness of the plates is increased to $5\frac{1}{2}$ inches, it may well be doubted if these difficulties can be successfully overcome by the rolling process.

It will not, perhaps, be out of place, to refer to the Return made to an Order of the House of Commons, dated May 17th, 1861, of the mode of manufacturing the armour plates of the *Warrior*, and three of her companion ships, and the number of plates condemned in the process of manufacture, with the reasons for their condemnation. The *Warrior's* plates, about 950 tons, were all hammered, and only five plates proved faulty in the process of manufacturing. Of the plates for the *Defence* and *Resistance*, together about 1200 tons, all but six were rolled; 45 were condemned for being blistered, laminated, or over-heated; and of the plates for the *Black Prince*, 950 tons in all, of which about 100 tons were rolled, and the rest hammered, 10 rolled plates and 32 hammered plates were condemned. It is to be observed, however, that in the manufacture of the hammered plates for the *Black Prince*, the whole operation was performed under the hammer, and the process of rolling the initial bloom into 6-inch bars was omitted. It is understood that in the hammered plates, which have failed comparatively under trial, this preliminary rolling has not been adopted, and to this, to some extent, their failure to stand the test may be due.

The experiments made at Shoeburyness by the Plate Committee on plates of various thicknesses, and upon the *Warrior* and other targets, have not yet been reported on by the Committee, but it is understood by the writer, who by the courtesy of the Committee has had the opportunity of observing many of the experiments, that those manufactured as described at the Thames Iron Works have exhibited uniform and superior excellence, which has also been exemplified in all the trials of sample plates selected by the Government officers, and fired at at Portsmouth.

The attempt has recently been made to effect a combination of the two processes of hammering and rolling; the slab 10 inches or thereabouts in thickness being forged under the hammer, then heated *en masse*, and rolled in the same manner as the pile, forming the final process described for the rolled plate. To this the writer objects, that this plan involves the serious difficulties already adverted to as consequent on the heating and rolling of so large a mass. Thus far experiment confirms this opinion, as the plates manufactured in this manner have proved under trial greatly inferior both to the rolled plates and those hammered at the Thames Iron Works.

In the minor qualities of smoothness and uniformity of thickness, it may be observed that the hammered plates are quite equal to the rolled, and with respect to cost of production up to the thickness of 4½ inches, the market price of hammered and rolled plates is the same; but if the thickness and weight be increased, the cost of rolling will, without doubt, be seriously enhanced, while that of hammering will remain but little, if at all, altered.

INSTITUTION OF CIVIL ENGINEERS.

March 4, 1862.—J. HAWKSHAW, Esq., President, in the Chair.

DESCRIPTION OF LOCH KEN VIADUCT, PORT PATRICK RAILWAY.

By Mr. E. L. J. BLYTH, M. Inst. C.E.

This viaduct was situated on a curve of half-a-mile radius, and carried a single line of railway over the loch at an oblique angle, so that the width of the waterway was increased from 265 feet to 360 feet, the depth of the water at the point of crossing being 29 feet in summer. It consisted of seven openings,—three of 130 feet each in the centre, spanned by wrought iron girders of the bow and string form; two semicircular arches of masonry, of 20 feet span, in the abutments; and two openings of 20 feet each at the ends, provided with flat cast-iron girders. Owing to there being scarcely any current, it was not deemed necessary to set the piers in the line of the loch, but they were placed at right angles to the viaduct, and each pair of girders was at a slight angle to the adjacent ones.

The foundations consisted of strong gravel, except in the case of the east abutment of the main openings, where a running sand was met with, and in this instance the lower courses of the masonry were laid on a bed of hydraulic lime concrete 2 feet in thickness. The two deep-water piers were each formed of two towers, 8 feet in diameter, placed 8 feet apart, and connected above the water level by semicircular arches of masonry. For each tower of the piers a cast-iron tube 8 feet in diameter, in six pieces, was sunk, the tubes being 36 feet and 42 feet in length for the east and west piers respectively. When the masonry was brought up to the surface, the upper castings of the tubes were removed. Around the piers 4,000 cubic yards of loose rubble stones were deposited, so as to produce an artificially deeper foundation. The tubes, when placed in position, sank from 1 foot to 2 feet, by their own weight, until they reached the gravel and sand, where they remained quite firm. This formed a good test of the sufficiency of the foundation, as the weight of the tubes on their narrow edges was equal to from 8 to 9½ tons per square foot, while the total weight of the foundations of the finished structure, including the moving load, was only about 6¼ tons per square foot.

The method adopted in sinking the tubes was that of ordinary well-sinking. Two plate-iron screw pans, of an inverted cone shape, were employed; one 2 feet in diameter at the top and 1 foot deep; and the other, which was only used for the harder portions of the excavation, 1 foot in diameter at the top and 1 foot deep. There were openings in the sides, covered with leather flaps, to prevent the material from escaping when the pans were filled. Three arms of round iron projected through the sides of the pans, and being connected to a long rod with a cross handle at the upper end, the screw pans were worked by four men, and when full were raised by tackle. The larger pan raised about 1 cubic foot of material each time, and the smaller one about one-fourth of that quantity. By these means the tubes were sunk in some instances as much as 18 inches in one day, the minimum being 2 inches per day in the case of the north tube of the west pier, where large boulder stones were encountered, rendering necessary the use of a screw pick. When the tubes had been lowered the desired depth, concrete was deposited within them, varying from 12 feet to 18 feet in depth in each tube. On this concrete, ashlar masonry was laid, the cordon course being of granite in large blocks, for receiving the ends of the girders, which rested on wrought-iron plates, laid on thick sheets of vulcanized India rubber, to lessen the effect of vibration.

The bow and string girders were each 136 feet 8 inches in length, and were segmental in form, the rise being 17 feet 6 inches, so that the segment was almost identical with a catenary curve, or the true curve of equal pressure. The sections of the upper and the under booms were identical. They consisted of a main plate, 24 inches broad and ¾ of an inch thick, and of two channel irons, each 8 inches by 4 inches in section, and ½ an inch thick, placed at a distance of 8 inches apart, between and to which the struts and ties, of the same section of channel iron, were rivetted. The transverse girders for carrying the roadway were 6 inches in depth at the ends, where they rested on the channel irons of the under booms, and 15 inches deep in the centre. The middle web of these girders was ¼ of an inch in thickness, and there were angle irons 3 inches by 3 inches by ½ an inch in section, at the top and the bottom of the web on each side. Every alternate girder projected 2 feet, from which T iron struts were carried up to the crossings of the diagonal bracing. The weight of the girders and roadway between the points of support was 88 tons, and of the ballast (2 inches in depth) 14 tons, making a total dead load of 102 tons; and taking the rolling load at 1 ton per lineal foot, the total load on one span would be 232 tons. The area of the upper boom was 33 inches, and of the under boom, exclusive of rivets, 27·4 inches. The distance between the centres of gravity of the upper and the under booms was 17·04 inches. The tensile strain on the under boom amounted to 4·04 tons per inch, and the compressive strain on the upper boom to 3·35 tons per inch. When the whole of the load was upon the girders, there was no compressive strain on any of the diagonals, but there were tensile strains varying from 3·4 tons to 7·5 tons, or equal respectively to 9 cwt. and 1 ton per square inch of section.

The author considered that the bow and string girder possessed advantages over the Warren or other lattice girders, with parallel top and bottom members; as in the latter class it was not possible to make the top and bottom members theoretically correct, without great labour and waste of material, and as, owing to the great variation in the strains on the diagonals, it was necessary that they should be of varying dimensions, involving in some cases even different sections of iron.

The girders were built in position on stageing, and the greatest amount of deflection of any one girder from its own weight was ⅝ths of an inch. Subsequently, when a locomotive engine, weighing 34 tons, was placed in the centre of each span, and afterwards was run over, first at 10 miles an hour, and then at 25 miles an hour, the deflection amounted to from three sixteenths to one quarter of an inch in each girder, there being no perceptible difference in either case. Finally, when four engines were coupled together, so as to give a load equal to 1 ton per lineal foot, the deflection only amounted to from ½ to ⅝ths of an inch. It was stated that the total cost of this viaduct had amounted to £13,000.

DESCRIPTION OF THE CENTRE PIER OF THE BRIDGE ACROSS THE RIVER TAMAR, AT SALTASH, ON THE CORNWALL RAILWAY, AND OF THE MEANS EMPLOYED FOR ITS CONSTRUCTION.

By Mr. R. P. BRERETON, M. Inst., C.E.

This communication embraced, in a narrative form, a detailed cccount of the preliminaries connected with the Albert Bridge, which crossed the River Tamar where it was only 1100 feet wide, with precipitous banks and a depth of water to the surface of the mud of 70 feet. A dyke of green stone trap intersected the clay slate formation at this point, and cropped out to the surface above the water on the western bank of the river. It was ascertained, by borings made in the bed of the river, that rock extended from the eastern side to beyond the middle of the stream, covered with mud or silt to a depth of from 3 feet to 16 feet. Subsequently, a thorough examination of the bed of the river where a centre pier would probably be built, by means of one hundred and seventy-five borings made within a cylinder at thirty-five different places, over an area of 50 feet square, enabled an exact model of the surface of the rock to be prepared showing the irregularities and fissures that might be expected. Eventually it was decided, from the information thus obtained, to erect one pier only in the deep water, instead of three, as would have been necessary for the spans required by the Admiralty; and when it was determined to proceed with the construction of the bridge in 1852, it was decided that there should be two spans of 455 feet, two of 93 feet, two of 83 feet 6 inches, two of 78 feet, two of 72 feet 6 inches, and nine of 69 feet 6 inches; the total length, including the adjoining land openings, being 2200 feet.

The centre, or deep water pier, intended to carry the weight of one-half of each of the two main spans, consisted of a column, or circular pillar, of solid masonry, 35 feet diameter, and 96 feet high, carried up from the rock foundation to above high water mark. Upon this were placed four octagonal columns of cast iron, 10 feet diameter, carried up to the level of the roadway, which was 100 feet above high water mark. Upon the tops of the columns, cast iron standards were fixed, to receive the ends of the tubes and chains which constituted the trusses of the bridge. The weight at the bottom of the masonry foundation was about 9½ tons per square foot, increased, when the bridge was loaded by passing trains, to about 10 tons per square foot.

In the construction of the masonry pier, a wrought iron cylinder, of boiler plates, 37 feet diameter and 90 feet in length, and open at the top and bottom, was sunk through the mud of the bed of the river to the rock. The water was then pumped out, and the mud excavated; the masonry being built up inside, and the cylinder above the ground afterwards removed. It was expected that, by forming a bank round the cylinder after being sunk to the rock, sufficient watertightness would be ensured for getting in the masonry. To provide, however for the contingency of excessive leakage, the cylinder was so constructed as to admit of the application of air-pressure. As the surface of the rock, although very irregular and ragged, had a general dip to the south-west, the bottom of the cylinder was formed with a corresponding bevel, one side being 6 feet longer than the other. A dome, or lower deck, was constructed inside, at the level of the mud, and an internal cylinder, 10 feet in diameter, open at the top and the bottom, connected the lower with the upper deck of the cylinder. The 6 feet cylinder, previously used for the borings, was fixed eccentrically inside the other, and an air jacket or gallery, making an inner skin round the bottom edge below the dome, was formed, about 4 feet in width, divided into eleven compartments, and connected with the bottom of the 6 feet cylinder by an air passage below the dome.

Details were then given of the construction of the larger cylinder, and of the mode of launching and floating it to its position. When accurately adjusted over the intended site, water was gradually let in, until the cylinder penetrated through the mud about 13 feet, and rested on some irregularities upon the rock, which caused it to heel over towards the east about 7 feet 6 inches. By letting water in upon the dome or lower deck, and loading the higher side with iron ballast, the cylinder forced its way through the obstructions at the bottom edge, and took a nearly vertical position. The air and water pumps were then set to work, and the greater part of the mud and oyster shells, which filled the compartments of the air-jacket at the bottom, was cleared out, and the irregular surface of the rock excavated; the bottom of the cylinder being now 82 feet below high-water. Subsequently, a leak having broken out through a fissure in the rock on the north-east, or higher edge, considerable difficulty was experienced in maintaining sufficient pressure with the air-pumps to keep the water down and the bottom dry. The leak was at length reduced, by driving close sheet piling into the fissure. When at its full depth, the cylinder was 87 feet 6 inches below high-water at the lowest place, and then a hemp gasket was worked under the edge of the cylinder, all round the outside, to assist its water-tightness. A ring of granite ashlar, 4 feet in width and about 7 feet in height, was then built in the air jacket; and a bank of clay and sand was deposited round the outside of the cylinder to compress the mud. When the water was pumped out of the body of the cylinder below the dome, and the excavation of the mud was being proceeded with, a leak broke out, and the water overpowered the pumps. Additional engines and pumps were provided, and efforts were made to diminish the leakage, with varying success; but as it required four pumps to keep the water down to 54 feet, recourse to air pressure in the body of the cylinder below the dome became imminent, and preparations for its application were made. To provide against the buoyancy, or upward pressure against the dome and cover, the 37 feet cylinder was loaded with 750 tons of ballast, in addition to its own weight of 290 tons. The pumps were then got into good order, and, by continued pumping, succeeded in keeping the water down. The mud was excavated, the cylinder below the dome securely shored across, and the rock levelled, when the masonry, in thin courses of granite ashlar in cement, in the body of the cylinder was commenced. As soon as the masonry reached the level of the air jacket ring, it was throughly bonded, the plates of the air jacket being cut out as it proceeded. Upon the top of the bonding course, two courses of hard brickwork in cement were laid, making a perfectly water-tight floor over the whole diameter of the column. Meanwhile, the masonry of the air jacket, where the leak occurred, was taken down, and the leak was diminished by additional sheet piling. The leak was discovered to have broken out at the same fissure as before, and had torn away the rock underneath the masonry of the air jacket and bottom edge of the cylinder, but the masonry itself was undisturbed.

The next operation was to draw off the water above the dome, and remove the ballast, to allow the masonry to be proceeded with, which it eventually did at the rate of from 5 feet to 7 feet in height per week. When it was 46 feet in height the influx of water was entirely stopped. After the masonry had been completed to the level of the plinth, the upper part of the cylinder was unbolted at the separate joints, and floated to the shore.

March 11, 1862.—JOHN HAWKSHAW, ESQ., PRESIDENT, in the Chair.

DESCRIPTION OF THE DELTA OF THE DANUBE, AND OF THE WORKS RECENTLY EXECUTED AT THE SULINA MOUTH,

By Mr. C. A. HARTLEY, Assoc. Inst. C.E.

In the autumn of 1856, by virtue of the Treaty of Paris, the European Commission of the Danube, consisting of representatives from each of the seven contracting powers, was charged to execute the works necessary below Isakcha, to clear the mouths of the river, as well as the adjacent parts of the sea, of the impediments which obstructed navigation. This Commission, to which the author had acted as Chief Engineer, was authorised to levy rates, to cover the expense of such works, on the express condition, that the flags of all nations should be on a footing of perfect equality.

In the preliminary studies of the three principal branches and mouths of the Danube, advantage was taken of the charts made by Captain Spratt, R.N., C.B.; and aided by these, and by the author's own surveys and personal investigations, a brief description was given of the chief characteristics of the progress of the river through its delta. The Danube, after a course of 1,700 miles, during which it received more than four hundred tributaries, and drained upwards of 300,000 square miles, passed in a single channel, 1,700 feet wide and 50 feet deep, the Bulgarian town of Isakcha, situated on the right bank, at 30 and 40 English miles respectively below the large corn exporting ports of Galatz and Ibraila. Isakcha was 76, 78, and 90 miles from the sea, following the courses of the Kilia, the Sulina, and the St. George branches, and 58 miles in a straight line. The head of the delta was reached, at Ismail Chatal, or Fork, 15 miles lower down, and here the fresh waters divided, never to re-unite; seventeen twenty-sevenths of their volume passing in an easterly direction by the Kilia branch, and the remaining ten twenty-sevenths in a south easterly direction by the Toultcha branch. At 11 miles below Ismail Chatal, this latter branch separated into two channels, the St. George and the Sulina, discharging respectively eight twenty-sevenths and two twenty-sevenths of the whole volume of the main river.

A short account was then given of the three channels, from which it appeared that the waters of the Kilia were delivered to the sea by twelve distinct mouths, only navigable for fishing vessels; that the river portion of the St. George offered no real obstacles, having an average width of 1200 feet, and a minimum depth of navigable channel of 16 feet, at seasons of extreme low water; and that in the upper reaches of the Sulina, disaster of every kind was imminent, from the many intricate windings and numerous shoals—the navigable width being rarely more than 300 feet, and the depth over the shallows, during seasons of low water, varying from 10 to 14 feet.

The delta proper was described as being bounded on the north by the Kilia branch, on the south by the Toultcha and St. George branches, and on the east by the Black Sea; the enclosed space comprising an area of 1,000 square miles, and forming a triangle of which the Ismail Chatal was the western apex, and the sea coast, from the mouths of the St. George to those of the Kilia, the base. During extraordinary high floods, the delta, being unprovided with artificial banks to contain the swollen waters, was almost entirely submerged; whilst at seasons of drought, its banks were elevated from 10 to 12 feet above the level of the river at the Upper Chatal, and from 8 to 10 feet at the Chatal of St. George. In the lower reaches of the three branches, the level of the river was but little affected by variations in the upland waters. Adjacent to the mouths, it never varied more than 1 foot, except when influenced by the wind. During high floods the inclination of the surface water of the Sulina branch was 3 inches per mile, whilst during extreme low water, it did not exceed 1 inch per mile. At times of ordinary high water, when the current had attained a velocity of from $2\frac{1}{2}$ to 3 miles an hour, the Danube, before it divided at Ismail Chatal, delivered a volume of water equal to nineteen and a-half millions cubic feet per minute; while in the dry season, when the current was reduced to 1 mile per hour, the flow did not exceed seven and a-half millions cubic feet per minute. At times of extraordinary floods, such as that which occurred in March, 1861, the velocity was increased to 5 miles per hour, and the volume of water then delivered amounted to sixty millions cubic feet per minute, or eight times the quantity discharged at ordinary low water. It was stated, as the result of careful observations, that when the waters were most surcharged, they carried to sea at the rate of 1 cubic inch of sedimentary matter, supposing it to be solidified into coherent earth, per cubic foot of water, and that not more than one-fortieth part of this proportion was transported when the floods had subsided. Thus, at the former period, upwards of 600,000 cubic yards of diluvial detritus passed into the sea by the several mouths of the river in twenty-four hours, and at the latter not more than 15,000 cubic yards. The results of these investigations accounted, in a great degree, for the changes which took plaee, from time to time, in the position and extent of the sand banks forming the bars across the several mouths. At times of high floods, these bars were further from the shore, their magnitude was considerably increased, and the depth over them was diminished; their distance from the shore, and their height being much influenced by the direction of the prevailing winds. The depth of the sea opposite the delta decreased to the north; thus, at 3 miles from the land, the depth was 16 fathoms opposite the St. George's mouth, and only 10 fathoms opposite the Sulina and Kilia mouths.

During the interval from 1830 to 1857, the shallows of the Kilia advanced fully one mile in the direction of the Sulina mouth. This, combined with the uncertain and changeable nature of the many branches issuing from the Wilkov basin to the sea, and the distance of the bars from the shore, were the chief considerations which induced the author to form an unfavourable opinion of the Kilia—in spite of its possessing the best river channel—and to recommend, in preference, the improvement either of the St. George or of the Sulina, where the sea depths were greater, and the advance of the sand-banks was less remarkable. In comparing the merits of the two latter branches, the author arrived at the conclusion, that in nearly every respect, the St. George offered decided advantages over the Sulina. It was true, that in order to reach the Kedrilles bar of the St. George, double the length of works would be necessary; but when once the sand-banks were passed, the greater sea depths opposite the St. George would insure, for a longer period, a constant good navigable depth at the sea entrance. The St. George's mouth was situated at the most salient angle of the delta, was nearer to the Bosphorus, by 18 nautical miles, than the Sulina, and was more favourably placed with regard to the safe manœuvring of vessels during N.N.E. winds.

Although there was a great difference of opinion as to the merits of each of the three principal branches, or mouths, all the technical authorities, who had studied the question on the ground, agreed in recommending that, whichever mouth was chosen, the system of improvement should be that of guiding the river water across the bar, by means of piers projected from the most advanced dry angles of the mouth: so as to concentrate the strength of the river current on the bottom of the proposed improved channel, by an artificial prolongation of the river banks into deep water. After considerable discussion, the Commission resolved to improve the bar channel of the Sulina, by guiding piers of a temporary character, in order to give the speediest relief to the navigation in the cheapest manner; but it was distinctly guaranteed, that this should not prejudice the choice of the mouth to be selected for permanent treatment. The author then received instructions to provide works which, for the expenditure of a sum limited to £80,000, should have the effect of giving an increased depth of at least 2 feet, over a period of from six to eight years. This duration of time was based on the assumption that, during such an interval, either the St. George would be opened, or it might be considered expedient to limit the improvement of the Danube to rendering permanent the provisional works.

The designs for the provisional works were then matured; and as it was found, in practice, that the cost of strong timber cribs, to be loaded with stone, and sunk at intervals of 20 feet along the line of the works, would exceed the original estimate, choice was finally made of a structure composed of timber piling and *pierre perdue*, surmounted by a timber platform 14 feet wide, strengthened occasionally by solidly constructed cribs of the same width. The works were commenced on the 21st April, 1858, a temporary staging, fixed on piles, being always run out from 200 to 300 feet in advance of the permanent piling. This staging supported nine crab engines, by which three rows of three piles, each 13 inches square, and 7 feet apart, were frequently driven, in one day, to a depth of 16 feet into the hard fine sand of which the bottom was composed. The piles were then immediately secured by double longitudinal walings and double cross-ties, the whole being surmounted by two thick tram pieces and planking, at 4 feet above the level of the sea. From this permanent platform, the close piling on the side next to the sea was driven. The daily rate of progress, during fine weather, was 20 lineal feet; and as soon as this length of sheet piles was completed, stones were thrown down to protect the footing in the sand, which was liable to be washed away by the action of the sea. This scouring action of the sea was so serious, when the skirt of the bar was reached, that it threatened at one time to demand, for the completion of the works, double the quantity of stone originally estimated. Several plans were tried to reduce its pernicious effects. That eventually adopted, and which was perfectly successful, was to advance the open pile work with all possible expedition, and then to pave the proposed seat of the pier with stones, delivered from barges. This pavement withstood the attacks of the sea, and offered no great obstruction to the penetration of the sheet piles, which, without being shod, had frequently been driven 10 feet into the ground, after having been forced through 8 feet of rubble stone. The section of the finished stone work was described as being a solid mass of closely packed third-class rubble, resting on a broad base, and narrowing upwards at slopes varying from 2 to 1, near the pier heads, to 1 to 1 and 1½ to 1 near the shore, until slightly below the level of the water, it became a mere ridge against the close piling. The time occupied in the actual construction of the piers was thirty-one months, exclusive of three winter months each year, during which the Danube was frozen over, and all work was suspended, but inclusive of two hundred and seven days when it was impossible to work, on account of stormy weather. The length of the north pier was 4631 feet, that of the south pier was 3000 feet, and the depth of water in which they were built varied from 6 to 20 feet. In their construction 200,000 tons of stone and 12,500 piles had been employed, and the cost had not exceeded ten guineas per lineal foot. The stone was brought from a distance of 60 miles, and its price delivered in place, varied from four shillings to five shillings per ton; the oak, used for the longitudinal and transverse timbers and for the planking and fender piles, cost two shillings and threepence per cubic foot, while the fir timber piles were delivered ready for driving for fourpence per cubic foot. The workmen, of whom there were generally three hundred, were composed of men belonging to more than ten different nations. Labourers were paid two shillings and sixpence, and carpenters four shillings and sixpence per day.

The changes which had taken place at the Sulina mouth, consequent on the projection of the piers, were then noticed. The depth on the bar, since the year 1829, had varied between the extremes of 7 and 12 feet, the least depth occurring during the subsidence of high-water floods, and the greatest when the the deposits lodged by those floods had been dispersed by autumal and winter gales. In April 1858, when the works were commenced, there was a navigable channel only 9 feet deep over the centre of the long shoal forming the Sulina bar. In November, 1859, when the works had been brought to a close for the winter, the north pier had advanced 3000 feet, and the south pier 500 feet, and then the depth on the bar was 10 feet, which was increased to 14 feet by the following April, although the works had remained stationary. Hopes were consequently entertained that the action of the north pier would, in itself, be sufficient to maintain an improvement; but these expectations were disappointed, as in August, when the north pier had reached a length of 4600 feet, the depth on the bar had diminished to 9¼ feet. Every exertion was then made to bring the opposite pier into play. Accordingly, during the the next three months, the south pier was advanced 1500 feet, and as it was now within 600 feet of the north pier, the good effect of concentrating the whole force of the river current directly on the bar, became at once apparent. Thus, on the 30th of November, 1860, there was a navigable channel of 12 feet, and on the 28th February, 1861, of 16 feet. Then came the breaking up of the ice in the river, and the furious descent of the extraordinary high floods, which caused so much damage at Galatz, and submerged the whole delta; but this time, instead of the depth on the bar being diminished, the swollen waters confined between the two piers and directed in a proper line, fairly swept away the remains of the bar on to the south bank and into deep water. From that time to the present, the depth had never been less than 16½ feet, and frequently it was as much as 17½ feet, over a navigable width of 500 feet. This result had been accomplished by works, the cost of which had not exceeded the sum that had been paid in one year only for lightening vessels over the bar; and without taking into account the excellent shelter which had been afforded, and the great risks which vessels formerly ran of being wrecked off the entrance.

In conclusion, the author expressed his gratitude to the members of the European Commission of the Danube, for the generous support he had always received; and especially to Major Stokes, R.E., the representative of Great Britain, whose enlightened policy, if allowed to prevail, could not fail, eventually, to insure to the commerce of all nations, the best possible means of water communication with the rich corn-growing countries bordering the shores of the Lower Danube.

March 18 and 25, 1862.—John Hawkshaw, Esq., President, in the Chair.

A DESCRIPTION OF WORKS AT THE PORTS OF SWANSEA, SILLOTH, AND BLYTH,

By Mr. James Abernethy, M. Inst. C.E.

The author stated that he proposed to give an account of the past and present history of these ports, so far as it possessed engineering interest, and to describe the works connected with them, rather with a view to the elucidation of general principles, than of entering into matters of detail.

The port of Swansea was situated in the centre of an extensive bay, at the embouchure of the River Tawe, up which the tide flowed for a distance of three miles; but as the ordinary flow of the river was trifling, the maintenance of the channel was chiefly dependent upon the ebb and flow of a large body of tidal water between the piers. Previous to the year 1791, there were only a few insignificant wharves near the mouth of the river, and there was a bar at the entrance, over which the depth of water did not exceed from 16 to 17 feet at spring tides. The effect of the construction of the piers, which still remained as they were completed in the year 1800, from the designs of Captain Huddart, F.R.S., had been to lower the bar and to drive it further out to sea; so that in 1831, the depth of water had been increased to 20 feet. The eastern pier was 1340 feet, and the western was 580 feet in length. The author then alluded to the report submitted to the Harbour Trustees by Mr. Telford, on the 5th of February, 1827, in which he recommended that the old and a proposed new channel of the river should be converted into floats,—as well as to the opinions of several other Engineers, including Mr. Jesse Hartley, who, in 1831, suggested that a new cut should be made for the river, which was to be "canalised" by the construction of a weir across the mouth, and that the town reach should be appropriated to a dock and half-tide basin. In the following year, Mr. Hartley, in a further report, adhered generally to his former plan, but advised, in addition, the deepening of the harbour by dredging. Fortunately, in the author's opinion, the works for the "canalisation" of the river were not carried out. A new channel was, however, commenced in 1840, and completed in 1844, at an expense of £23.000. Its effect had been, to lessen the risk to shipping, and, by giving a better direction and greater force to the outgoing current, to improve the navigation. In 1845, Mr. Rendel was consulted as to floating dock accommodation; and under his direction, the construction of an entrance, with a double cill, was proceeded with, as a preliminary step to the conversion either of the river, or of the town reach, into a float; but of this work the masonry alone was executed.

In his first report to the Trustees, in February, 1849, the author proposed the formation of a dock on the site of the town reach, or old bed of the river. It was subsequently determined to construct a dock and half-tide basin, of the respective areas of 11 acres and 2¾ acres; with a lock entrance to the dock, 160 feet long and 56 feet wide, and an entrance to the half-tide basin, 60 feet in width, having a depth of water over the cills of 22 feet 6 inches, and 25 feet 6 inches at high-water of ordinary spring tides. A small lock connected the Swansea canal with the float, and another, at the head of the float, communicated with the various works on the banks of the river above. A small dock leading from the float, with an extensive range of warehouses round its margin, was also constructed at the same time, for the Duke of Beaufort. The works for the lock and float were commenced in November, 1849, and completed in December, 1851; those for the half-tide basin were begun in 1856, and were finished early in 1861. The total cost of these works, exclusive of the quay walls, had amounted to £95,688. In addition, the lower portion of the river to the pier heads was straightened, and both it and the new cut were deepened by dredging. By these means the depth of the entrance channel had been increased 4 feet since 1850. There was nothing peculiar in the construction of the works, but their execution was attended with some difficulty, as a large portion had to be performed by tide work, with as little interruption as possible to the trade of the port. The foundations varied from hard concreted gravel to soft sandy clay, extending to a considerable depth.

The most important work connected with the port of Swansea was the range of floating dock accommodation called the South Dock, which was formed on the foreshore of the sea beyond high-water mark. An Act was obtained, in 1847, for the construction of this dock, according to a design furnished by Mr. T. Page, M. Inst. C.E. In 1850, the author was requested to make the necessary plans for a trumpet-mouth entrance basin, having an area of 3 acres; for a half tide, or outer dock, entrance, 70 feet in width, with a single pair of gates, having a depth of water over the cill of 24 feet; for a half-tide basin, or outer dock, containing an area of 4 acres, with a depth over the cill of 25 feet 6 inches; for an entrance lock, 300 feet long and 60 feet wide, divided by intermediate gates so as to form a greater or a smaller lock, with an average depth over the inner cill of 22 feet 6 inches; and for a dock having an area of 13 acres, with a depth of 24 feet. Considerable progress had been made with these works, when they were suspended, in 1855, for want of funds. They were resumed in 1857, and were completed in 1859, at a total cost of £169,073. One of the first operations was the formation of an embankment to exclude the sea. Careful observations showed that the main, action of the sea and the set of the tides were to the eastward, towards the Mumbles headland. It was, therefore, decided to construct a series of timber groynes, at intervals of 1500 feet, extending from the shore to the line of the proposed embankment. Rough boulder gravel, found immediately under the sand and the made ground, was tipped between the seaward ends of the groynes, until a shingle beach, of great depth, was gradually formed, which served as a face to the embankment, and proved an effective barrier to the encroachments of the sea. The centre of the embankment was composed of the clay and peat found in the excavations, so that something like a puddle dyke was formed, and very ordinary means were sufficient to keep down the accumulation of water within the works. When the sea embankment had advanced some distance, the masonry of the dock walls was proceeded with. These walls consisted of rubble with coursed rubble facework to a height of 2 feet below the general level of the surface of the water in the dock. They were faced in the upper part with ashlar, projecting 3 inches beyond the rubble facework. They were backed with the lightest and driest material that could be procured, in layers forming an angle from the wall, and rubble drains, with pipes for carrying off any spring, or upland waters, were placed at intervals in the walls. In no instance had any failure taken place, although the walls were subjected to a severe test; inasmuch as they were nearly completed when the works were suspended, and, on their resumption, the dock and outer basin were found to have become filled with water. Details were then given of the lock and entrance, from which it appeared that they were constructed, generally, with elliptical inverted arches of rubble, the quoins and floors, or platforms, being of sandstone ashlar, obtained from the coal measures in the neighbourhood. The pointed cill stones and the hollow quoins were of greenstone and syenite, from the Carling Nose and Barnton Mount Quarries, near Edinburgh. The cill stones were carefully toothed and bonded into the floor stones, so as to avoid a long straight joint. The recess and side walls were of rubble, with ashlar facework in the upper portion, similar to the dock walls, but the wing walls were faced throughout with ashlar. The filling and discharging culverts were of brickwork. The sluice frames and paddles were of cast iron, faced with brass. In the lock and entrance gates, the heel mitre posts and the lower rib were of the best teak and English oak, and the ribs and planking were of pitch pine. Across the lock there was a swivel bridge, in one leaf, consisting of two wrought iron tubular girders, with a superstructure fitted for railway or road traffic. There being no backwater, the waste from lockage was supplied by a steam centrifugal pumping engine of 24 H. P.

The successful application of hydraulic power for working the usual hand gear at the float lock, and at the lock at Newport dock, with much heavier gates, determined the author to adopt the same plan at the new dock entrance, as in case of any accident happening to the hydraulic machinery, the usual means were then always available. As it was of the utmost importance, in the shipping of Welsh coal, that as little breakage as possible should take place, the hydraulic drops, or hoists, were so constructed as to deliver the coal into the hold of any class of vessel immediately at the hatchway; allowance being also made for the difference in size of the broad-gauge coal waggons, the weight of which varied from 14 to 19 tons. The various machines employed for opening and shutting the gates, bridges, and sluices, for working the capstans, for discharging ballast, and for loading coal, as well as for the shipping and discharging of general cargoes, were upon Sir William Armstrong's hydraulic system, having accumulators equivalent to an effective pressure of 750 lbs. per square inch. High-pressure, direct-acting steam engines of 80, 30, and 12 horse-power, were used at the Swansea Docks; the distribution of power being regulated by self-acting arrangements in connection with the accumulators, apportioned in each case to the powers of the machines at present erected. At the float lock, each line of shafting was driven by a small water pressure engine placed near the middle; but owing to the length of the lock at the new dock, and other minor circumstances, the line of shafting was broken, and was driven by two separate hydraulic engines on each side of the lock. The time employed in opening, or in closing the gates, was about two minutes and a half, which was as great a speed as could be adopted with safety to the gates. The sluices were worked direct, by a piston and plunger placed immediately above them. The wrought iron swing bridge was turned in and out by means of two hydraulic cylinders acting in opposite directions, and attached to a drum beneath the bridge by means of a chain. The bridge could be opened, or shut, in one minute and a half. The ballast cranes were each capable of discharging from 350 to 400 tons per day. Coal was brought up for shipping on two distinct systems. In one, it was carried in end-tipping waggons, and in the other, in wrought iron boxes with false bottoms, each holding 2½ tons, and four being placed upon one truck. About 1000 tons per day could be shipped by each machine; and both could deliver the coal on board at a faster rate than the "trimming" in the hold of the vessel could be accomplished. The machine for delivering the coal from boxes was placed above that for discharging the end-tipping waggons, and both were commanded by one man. By this combination, a cone of coal could be formed in the hold of the vessel, by lowering the boxes through the hatchway, and then, upon this cone, the remainder could be delivered from the shoot in connection with the waggon-tipping arrangement. Details were then given of the mechanism by which the hoists were worked, from which it appeared that when a loaded waggon was run on to the rails of the tipping frame, the cradle on which it rested was either raised, or lowered to to the level of the shoot, as might be necessary, having a range of 21 feet for that purpose. The catches of the waggon door were then knocked out, and the pressure applied to the tipping frame. The empty waggon was brought back to the point where the rails of the traverser on the cradle and the staith met. The catch securing the traverser to the cradle was then liberated, and the waggon was allowed to run down to the return line, on to which it was pushed. The traverser was next hauled back to the cradle by a ram, and lowered to the point, defined by self-acting stops, where the full waggons were taken on. The system pursued in discharging from the boxes was then minutely described.

With respect to the work performed by the hydraulic machinery, and its cost, it seemed that, during the year ending October, 1860, the actual expenditure for engine power had been £22 16s. 1d. per week, or at the rate of 0·26 of a penny per cubic foot of water used for pressure. The cost of working was, by the cranes 9-10ths,—by the combined drop 5-10ths,—and by the waggon drops 4-10ths of a penny per ton. But inasmuch as the engine power was never fully employed, this statement must not be received as conclusive, as regarded the capabilities of the machinery. With the 80 H. P. steam engine, it was believed that 100,000 cubic feet of water could be pumped per week, at a cost of £30, or at the rate of 0·072 of a penny per cubic foot of water; and that of this quantity 80,000 cubic feet would be available for working the cranes and the coal drops at a cost, for the hydraulic power alone, of about one farthing and one-seventh of a penny per ton respectively.

The commercial effect of the construction of the dock works and of the general improvement of the harbour was shown by the great increase in the tonnage of vessels frequenting the port. In 1851, on the completion of the first, or north dock, this amounted to 269,454 tons only. In 1860 it was 582,355 tons, and during the year 1861, the foreign tonnage had increased 10 per cent., and the trade was likely to extend, owing to improved communications with the steam coal and the iron producing districts, as well as with the heart of the Kingdom.

As a detailed description of the works constructed at the entrance of the port of Blyth had already been communicated to the Institution by Mr. M. Scott, M. Inst. C.E., the author only alluded to the change which had taken place in the condition of the channel since the year 1854. It was then exceedingly tortuous, in many places dry at spring tides, and the entrance was obstructed by a spit of sand. As the channel ran, for its entire length, parallel with a lee-shore, exposed to the direct action of north-easterly seas, scarcely a winter passed without vessels being wrecked on the beach on the southern side. To remedy these evils, an eastern breakwater, 4500 feet in length, and a western half-tide training wall, 4000 feet in length, had been constructed, and the channel had been straightened and deepended by dredging, at a total cost of £67,320. In designing these works, the author was guided by experience obtained at Aberdeen harbour, the entrance to which was similarly situated. The result of the construction of the works at Blyth was, that the outgoing current had been increased to a velocity of 5 knots per hour, at its greatest strength, whereas formerly it was lost immediately on passing the line of the foreshore. The bar, or spit of sand across the entrance, had been entirely removed, and there was now a depth of 8 feet or 9 feet at low water immediately opposite the breakwater. The depth throughout the channel had been increased 4 feet, and vessels, after passing the breakwater, were effectually protected from the action of north-easterly, or on shore gales.

In the year 1854, an act was obtained, after considerable opposition in Parliament, for the construction of works at Silloth, on the Solway Frith, the general design of which was stated to be due to Mr. John B. Hartley, M. Inst. C.E., although the direction of their execution was intrusted to the author. The works comprised a pier, or jetty, 1000 feet in length, on the seaward side of the dock entrance, and entrance channel parallel with the jetty, 100 feet in width at the bottom, which was generally 16 feet below the level of the adjoining beach, with side slopes of 6 to 1, and a fall of 2 feet 6 inches in its entire length;—an embankment on the foreshore, projecting 400 feet beyond high-water mark, and inclosing the entrance to the dock, which was 60 feet in width, with a depth of water over the cill of 24 feet at high water ordinary spring tides;—and a dock containing an area of 4 acres, with a depth of 25 feet 6 inches. A general description was then given of the principal peculiarities of the tidal and other features of the estuary. The navigation at Silloth Bay had remained unchanged for a long time, and the anchorage within it afforded good holding ground, and was sheltered by sandbanks from the action of heavy westerly seas.

The objections which were urged against the scheme were then stated, and contrasted with the results which had followed the completion of the works. It was considered that the flowing current might be deflected to the English side, and would there form the principal navigable channel; and it was believed that, if a training work was constructed below Annan point, accretion would take place on the upper part of Powfoot sand, and a constant navigable channel would be maintained from Annan to Silloth. The works indicated that great care must be exercised, in projecting solid moles from the foreshore of an estuary, on any sandy coast, as an entrance to ports. The sea channel, formed inside the jetty, had proved successful, and its maintenance was no longer a matter of doubt, as the depth and the sectional area remained the same as on its first formation two years back. With respect to the construction of the docks, by the aid of wells sunk on the site of the works, and a moderate degree of pumping power, the sand and gravel, of which the excavation consisted, were drained, and by the aid of sheet piling and concrete, no difficulty was found in making good foundations.

The entrance gates, cranes and coal hoists were worked by hydraulic machinery, similar to that at Swansea and at Newport, except that the coal hoists were exceptional, and deserved special notice, as involving the question of the relative capabilities and advantages of a high or a low level system for loading coal. The author believed, that although there might be situations where the former system must be carried out, yet that at such places as Silloth and Newport, the low level system was superior, both for convenience and economy; as the cost of high level erections was avoided, siding accommodation could be afforded with greater facility and at less cost, while the quays were unencumbered, except by the spaces required for the hoists. The quantity of coal that could be put on board was only limited by the amount that could be trimmed in the hold of the vessel. The cost had been found to approximate to that at Swansea, one farthing per ton. The hoists, which were constructed to receive both tipping and hopper waggons, were then minutely described, and it was stated, that the total cost of the works which had been executed at Silloth from 1856 to 1859, had amounted to £122,000.

TESTIMONIAL TO MR. J. E. M'CONNELL, C.E.

The officers and workmen employed in the locomotive department of the London and North-Western Railway lately presented a handsome testimonial to their late superintendent, upon his retirement from office. The testimonial consisted of an elegant and massive silver épergne or candelabrum, with cut glass centre dish for flowers, and six branches supporting cut glass dishes, which may be removed for the purpose of holding candles. The stem represents the vine with leaves and grapes, beautifully modelled and arranged; the base is triangular. On one compartment is engraved the inscription as given below; in the second, the arms, crest, and motto of Mr. M'Connell; and on the third a locomotive engine and tender, being a correct representation of one belonging to the London and North-Western Railway Company. The candelabrum stands upon a very massive silver-mounted plateau, with vine ornaments. The other part of the testimonial consists of a pair of very elegant silver flower stands, with cut-glass dishes, to match with the centre-piece, each engraved with the arms, crest, and motto of Mr. M'Connell. The following is the inscription:—"Presented to James Edward M'Connell, Esq., C.E., by the officers and workmen employed in the locomotive department of the Southern Division of the London and North-Western Railway, upon his retirement from the office of superintendent, as a testimonial of the regard and esteem in which he is held, and of their grateful appreciation of the great interest he has invariably taken in their welfare.—Wolverton, March 8, 1862." This was accompanied by an appropriate address, bearing 1966 signatures. On the occasion of the presentation, which took place at Wolverton, the meeting was presided over by the rural dean, the Rev. R. N. Russell. In the course of the various speeches delivered, allusions were made to the labours of Mr. M'Connell for the welfare of the workmen under his charge, and their wives and children, by the establishment of schools, classes, and other educational means, the erection of churches, the foundation of a savings bank, a sick and benefit society, and other local institutions, amongst which, and not the least important, being the Mechanics' Institution, the foundation stone of which was laid, in May last, in the presence of the directors and principal officers of the company by his Grace the Duke of Sutherland.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

"THE ROYAL WILLIAM."

(*To the Editor of the* ARTIZAN.)

DEAR SIR.—Permit me to correct an error that appeared in your last number.

The *Royal William* was built in Liverpool by Thomas Wilson, in 1837, and was the first steamer that crossed the Atlantic, from the Port of Liverpool, and the third from Great Britain. She sailed for New York in July, 1838, and again in November, and also in December, in the same year. One voyage being made in 13 days 9 hours. She has since been employed in the regular service of the City of Dublin Company, for whom she was built.

The dimensions are as follows:—Length 172ft. 5in.; breadth, 24ft. 6in.; depth, 16ft. 6in.; registered tonnage, 282; gross tons, 524. Her enginea were made in Liverpool, by Fawcett, Preston & Co., and are 270 horse power, having 60 inch cylinders, and 5ft. 6in. stroke. G.

NOTICE TO OUR READERS.

In consequence of an unusual press of matter, we are unavoidably obliged to defer giving, until next month, the textual description of Plate 209 (*Apparatus for Testing the Strength of Steel.*)

NOTICES TO CORRESPONDENTS.

G. H.—Tracings and particulars received.

F. B. (Strade Ferato-Arona).—Your letter received; the one enclosed therein has been forwarded as requested.

G. J. C. D.—Received and used.

SIGMA (Derby).—There is little chance of your obtaining such an appointment as the one desired. You have not advanced sufficiently in the essential branches of education. Continue to devote your leisure time to study, and we will furnish you, by post, with a list of suitable books, and some further advice. Send your address.

W. H. (Greenwich Road.)—We regret our inability to afford the desired information. We have sought in vain. Send further particulars for our guidance.

MERSEY.—Refer to Ure's *Dictionary of Arts, &c.*; Brand's *Chemistry*, and Tomlinson's *Encyclopædia*. You will find these works, as also, we believe, in the Free Library, Liverpool.

REFRIGERATOR.—Particulars received, wood block in hand, and will, with the description, be inserted in our next.

FRANS ANRESE (Bjorneborg, Finland).—Full particulars in reply to your inquiry will be sent you through the post.

D. R. (Dumfries).—We have enquired, but regret we cannot obtain for you what you want. Write again within one month, and state qualifications.

J. W. (Alexandria).—Answer will be sent by post.

W. P. (Cairo.)—Received with thanks.

W. H. G.—Received and used, as you will perceive.

H. & D. C.—The following particulars have been furnished by Mr. G. Walcott, C.E.:—

A PROTECTING GUN.

SIR,—Besieged towns have often been surrendered through explosions occurring at their powder magazines and battery stores; for instance, at St. Jean d'Acre, and last year Gæta. Thus, the materials accumulated for defence proved to be the greatest source of destruction, notwithstanding, it is presumed, all possible care. No man can dispose of his energies to the best effect when subject not only to an enemy's missiles, but the dread of death to himself and surrounding comrades, which might occur at any moment, through no error on his part, by an explosion in the materials carefully stored for use in close proximity. Science surely should be capable of relieving the faculties of soldiers from such trying ordeals as death confronting them from both sides. Permit me to suggest an alteration in the working of guns in the direction of making them what they should only be—destructive to opponents. To do this, the use of gunpowder requires to be discontinued, and the means employed should merely be subject to explode when desired *inside* guns. This proposition can be solved by mixing *inside* guns, two or more agents harmless when single, but powerfully explosive, combined. Say, for instance, two different gases compressed together sufficiently to obtain the required explosive force, which could easily be effected by the following arrangements. At any suitable spots, erect underground a small apparatus for generating the desired gases; lay main pipes underground with two different branches to every gun, their terminations having valves also buried, with a long rod for turning them at the top. These valves to be connected to a cannon by two lengths of strong wire, coiled flexible tubes covered so as to be air tight, each of which is to have a cylinder fitted with piston, plug, and lever rod adapted for forcing the gas through the tube when desired. Previously to charging a gun with two *compressed* gases, forming when combined a powerful explosive compound, an elongated ball or shell should be placed therein either through the breach or mouth, so as to obtain a perfectly air-tight chamber inside the gun, by covering the lateral sides of the ball with grease, which on being well set up, would close the bore hermetically. By turning on the gases all air in the compartment made would be ejected through the touch-hole. A percussion cap of extra length is desirable, in order that the end may enter deeply into a cup of grease surrounding the touch-hole to seal this aperture. The charge of gases may now be forced to the necessary extent inside the gun, after which the second set of valves firmly fixed into the under part of the gun, in connection with the gas tubes should be turned off previously to firing. The flexibility and extra length of the tubes would allow for any recoiling or deviation of the gun.

Yours respectfully,

GEORGE WALCOTT, C.E.

THE "REIVER."—The indicated horse-power obtained at time of trial was from 2500 to 2600 horses.

GAS ENGINEER.—The plan to which you allude, and which is the invention of Mr. Geo. Walcott, of Abchurch-lane, London, has been put into practical operation in some of the smaller gas-works. The advantages stated to be obtained by the introduction of Mr. Walcott's Improved Retort Bed, are as follows:—"The advantages of this Retort Bed are the arrangement for returning the heat absorbed by the mass of the brickwork into the furnace to intensify combustion, which facilitates the introduction of clay retorts into small gas-works, as neglect of the furnace fire at night would not cause a draught of cold air through the open ashpit into the furnace, but, instead, heated air only. The mode for destroying the incrustation inside the retort dispenses with the painful labour of scarifying. As every piece is made with a key letter, corresponding with similar letters on working drawings, each piece may be placed at once into its intended place. The dispensing with the end wall and covering arch enables longer and larger-sized retorts to be erected without difficulty in old beds, and the fire that was previously playing uselessly on the end, also the side walls and covering arch, would be diffusing itself beneficially on the enlarged retorts." In a small gas-works during a whole winter, the consumption of coke in the furnace was 22 per cent. of the yield, the usual consumption in such sized gas-works being 35 to 40 per cent.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

THE CASE OF MR. SCOTT RUSSELL.—JUDGMENT.—This case came before the Court of Chancery for judgement. It was the petition against the adjudication of bankruptcy of Mr. John Scott Russell, of 28, Great George-street, Westminster, and of Millwall, shipbuilder, pronounced by Mr. Commissioner Goulburn on the 22nd of February. That decision was disputed on two grounds, namely, that there had been no act of bankruptcy, and, secondly, that there was no valid petitioning creditor's debt. Mr. Scott Russell was under contract to build the *Great Eastern* steamship, and he made a sub-contract with Mr. Lester (the petitioning creditor) for the performance of works to the upper deck for £5,500 and time was to be an important ingredient in the contract. The sub-contract was not performed in time, but all the money except £500 was paid. There were other cross demands between Mr. Scott Russell and Mr. Lester for materials, labour, &c. After the accident to the *Great Eastern* disputes arose between the company and Mr. Scott Russell, and an action was brought by the latter, and finally the matter was referred to arbitration, in which an award was made in favour of Mr. Scott Russell for £18,900; but the sum was given after striking out all items relating to the works Mr. Lester had undertaken to perform, amounting to £2,000. Mr. Scott Russell was obliged to appeal to the Court of Queen's Bench to enforce the award, and he proceeded for the £18,000. Mr. Lester pressed Mr. Scott Russell for the payment of the balance due to him, and on the latter demurring to pay more while there was the claim unsettled between the company and their contractor, an action was brought by Mr. Lester, and that action was itself a subject of arbitration, which arbitration was at present proceeding. The Lords Justices required that the question should be argued, and it lasted several days. Lord Justice Knight Bruce said he must assume, for the sake of arguing the other question, that there was a petitioning creditors's debt. He was of opinion, after hearing the evidence which had been adduced before them, that there was no act of bankruptcy committed by Mr. Russell. If, however, he had only the evidence before him which was taken by the Commissioner in Bankruptcy, it was probable that he might have come to the same conclusion as that gentleman. The adjudication of bankruptcy would be annulled, and the petition dismissed. He must express his opinion that petitions in bankruptcy ought not to be presented in the case of balances of disputed and complicated accounts. Lord Justice Turner concurred. The adjudication in bankruptcy against Mr. Scott Russell was therefore annulled, and the petition dismissed.

THE LAW OF TELEGRAMS.—In the Lord Mayor's Court, on Saturday, an action was tried, Harvey *v.* the Electric Telegraph Company, for the non-delivery of a telegraphic message at Chatham. It appeared that the station there belongs to another company, and having been closed at an earlier hour than usual, the message could not be delivered in time, inasmuch as the change was not known to the clerk of the Electric Telegraph Company. The jury gave a verdict for the company, on the ground that their contract terminated with the wires under their control. Leave was granted to the plaintiff to move for a new trial in a superior court.

TABLE OF SPECIFICATIONS HAVING REFERENCE TO THE TENDERS

PARTICULARS.	Present ships as standards. *Lord Warden, Princess Helena.*	Rennie & Co., London.	Westwood, Baillie, Campbell, and Co., London.	Laird, Birkenhead.	Samuelson, Hull.	Samuda, London.	Thames Iron Works, London.	Forester, Liverpool.
Keel	5 × 1	6 by 1	6 × 2	No outside keel ...	6 × 2	No Keel	No keel	No keel
Keel Plating	Nil	....	....	¾	....	⅞	....	....
Stem	5 × 1¼	6 by 1	6 × 2	6 × 2¾	6 × 2	7 × 2¼	5 × 1	6 × 1½
Stern Post	5 × 1½	6 by 1	6 × 2	6 × 2¾	6 × 2	7 × 2 × ¼	5 × 2 × ½	6 × 2
Frames Midship	3 × 3⅜	3 by 2½ by ⅜	3½ × 3 × ⅜	3½ × 2½ × ⅜	4 × 3	3½ × 2½ × ⅜	3 × 2½ × ⅜	3 × 2½ × ¼
„ Space	14 to 24	18 to 22	18	18	15	20 throughout	16 to 24	18
„ Fore and Aft	3 × 3⅜	2½ by 2½ by 5/16	3 × 3 × ⅜	3½ × 2½ × ⅜	3 × 2½	2½ × 2½ × 5/16	2½ × 2 × ⅜	3 × 2½ × 5/16
„ Space	24	22	24	21	20	20	16 to 24	18
„ Reverse	Nil	2½ × 2 × 5/16	3 × 3 × ⅜	3 × 3	3 × 2½	2½ × 2½ × 5/16	2½ × 2 5/16	2¼ × 2¼ × ⅜
„ Floors	14 by ⅜	12 × 5/16	12 × ⅜	12 × ⅜	12 × ½	12 × ⅜	10 × ⅜	12 × 5/16
Keelsons	8 × ¼	5 × 4½	Not given	Requires a sketch to explain	4 × 3	3 × 3 × ⅜	No size given	3 × 3 × ⅜
Beams	8 × ¼	5 × 4⅜	6 × ¼	5 × 2½ × ⅜	7 × ½	6 × 5/16	5 × ⅜	5 × 3 × ⅜
„ Angle Irons	2 × ¼	Not given	2½ × 2 × 5/16	2½ × 1¾ × ¼	3 × 2½ × ⅜	2 × 2½ 5/16	2 × 2½ × ¼	5/16
Bulkheads	3 in No. ¼	5 in No. 5/16 to 3/16	3 in No. ⅜ to ¼	According to Board of Trade.	4 in No. Accord. to B. of T.	3 in No., 5/16	4 in No. ⅜ to ¼	4 in No. ¼ × 3/16
„ Angle Irons	2½ × ¼	Not given.	....			2½ × 2½ × 5/16	2½ + 2	3 × 2 × 5/16
Stringers	14 × ¼	14 × 5/16	18 × ½	24 × ⅜	Not given	14 × ⅜	12 × ⅜	18 × ⅜
„ Angle Iron	3½ × ⅜	....	3 × 3 × ½	3 × 3 × ⅜	4 × 3	4 × 3 × ⅜	2½ × 2 × 5/16	4 × 4 × 7/16
Floating Garboard	½ × ⅜	½ to ⅜	⅝ to ½	½ to 7/16	⅝	9/16 to ½	⅝ to 9/16	7/16
„ Bottom	½ × ⅜	⅜ to 5/16	9/16 to ⅜	7/16 to ⅜	⅝	9/16 to ½	⅜ to 5/16	⅜
„ Bilge	⅝ × ⅜	5/16 to ¼	7/16 to ⅜	⅜ to 5/16	⅝	⅜	⅜ to 5/16	5/16 to ¼
„ Shear Streak	⅜	5/16 to ¼	½	½ to 7/16	⅜	½ to 7/16	½ to 7/16	7/16
„ Top Sides	....	5/16	⅜	Not given.	⅜	⅜ to 5/16	⅜ to 5/16	5/16 to ¼
Riveting	Single	Butts only d'ble.	Butts and bot'm. dbl.	Butts only double	All Single	Butts dbl. only	B. dbl. only	B. only d'ble.
Draught of Water	6·6	....	....	....	....	....	....	....
ENGINE, Nominal H.P.	200	....	220, oscillating	....	212, oscil.	220 oscillating	....	....
„ Cylinders	D. 53, St. 42. 17′ 3″ centre	D. 51, St. 54	D. 56″, St. 48	D. 52, St. 48	D. 58, St. 51	D. 58, St. 54	....	D 52, St. 42
„ Wheels	21′ 6″	16′	18′ 6″	....	22′ over floats	18′	....	14′ 6″ centre
„ Floats	4′ 10″ × 3′3″	7′ 2″ × 3′ 2″	12 in No. 7′6″ × 2′9″	....	....	8′ × 3′ 6″	....	8′ by 3′ 6″
Average Revolutions	32	38	40	40 to 42	36	36 to 37	....	42
BOILER, Fire Grate Area	140	205	210	165	190	225	....	219
Total Heating Surface	3860	4712	5500	4250	4342	5700	....	5625
Tubes, Diameter	2¾	2¾	¾	2¾	2¾ × ⅛	2¾	....	Not given
„ Number	613	822	800	850	880	1100	....	....
„ Length	7′ 3½″	7′	6′ 6″	5′ 6″	5′ 9″	6′ to 7′	....	....
Consumption of Fuel per hour	35 cwt.	48 cwt.	55 cwt.	35 cwt. to 40 cwt.	37 cwt.	50 cwt.	....	....
Working Pressure	20 lbs.	....	24lbs. p. 40lbs.	25 lbs. per 40 lbs.	20 lbs.	....	....	....
Number of Boilers	1	2	....	4	2	2	....	2
„ Furnaces	6	8	....	10	10	10	....	12
Length and Breadth of Furnaces	9′6″ × 2′5½″	7′ 6″ × 3′ 5″	....	5′ 6″ × 3′	6′ 3″ × 2′	7′ 6″ × 3′	....	6′ 6″ by 2′ 9″

SHIPBUILDING AND MARINE ENGINEERING

The following is a List of the Vessels composing the Fleet of the Glasgow and Calcutta

Names of Vessels	Asia	City of Glasgow	City of Calcutta	City of London	City of Edinburgh	City of Benares	City of Manchester	City of Madras	City of Dublin	City of Tanjore
Names of Builders	Archibald M'Millan & Son	....	........Bar	clay, Curle,	& Co.	....	....	.. Robert St	eele & Co...	....
Where Built	Dumbarton	....	........Sto	bcross, Glas	gow	....	Greenock	....	Cartsdyke	....
Date of Launching	1846, Sept. 20	1848	1850, March 10	1851, Feb. 18	1852, Feb. 9	1853, March 10	1854, May 29	1855, Feb. 19	1855, July 31	1856, January 8
Length of Keel and Forerake (Builders' Measurement)	....	130ft.	130ft. 6in.	134ft. 9in.	140ft. 3in.	161ft. 3in.	163ft. 8in.	190ft.	190ft.	190ft.
Breadth of Beam	....	29 1¼	28 7	29 0½	29 2	30 2	30 0½	30	30	30
Tonnage (Customs Measurement)	....	507 4/94	192 55/94	526·37	555·38	692 23/94	699 77/94	823 35/94	823 33/94	823·38
Length—Fore part of Stem to after part of Stern-post	118·2	127·7	129·3	133·5	139	163·8	165·3	194·8	200·5	194·9
Breadth, extreme	26·1	26·7	25·8	26·4	26·1	27·4	27·1	29·2	30·2	30·0
Depth of Hold, amidships	19·2	19·9	20·2	20·4	20·1	20·9	21·1	21·8	20·7	20·7
Tonnage, under deck	476·68	566·78	541	581·28	598·58	750·87	766·37	914·32	813·73	799·13
Poop or Break	48·17	....	....	....	....	....	....	....	....	....
Register (gross)	524·15	566·78	541	581·28	598·58	750·87	766·37	914·32	813·73	799·13
Figure-head	Full Male	Full Fem.	Full Fem.	Full Fem.	Full Fem.	Full Fem.	Bust Fem.	Demi Fem.	Demi Fem.	Full Fem.
Galleries	None	None	None	None	None	None	None	None	None	None
Stem	Common	Common	Common	Common	Common	Common	Common	Clipper	Clipper	Common
Stern	Square	Square	Square	Square	Square	Square	Square	Square	Square	Square
Decks	1 & Poop	2	2	2	2	2	2	2	2	2
Bowsprit	Standing	Standing	Standing	Standing	Standing	Standing	Standing	Standing	Standing	Standing
Masts	3	3	3	3	3	3	3	3	3	3
Rigged	Ship	Ship	Ship	Ship	Ship	Ship	Ship	Ship	Ship	Ship
Bulkheads	....	....	....	....	....	....	....	2	2	2
Classed A 1 at Lloyds (years)	10	13	13	13	13	13	13	12	12	12
Material built of	Wood	Wood	Wood	Wood	Wood	Wood	Wood	Iron	Iron	Iron
Port of	Glasgow	Glasgow	Glasgow	Glasgow	Glasgow	Glasgow	Glasgow	Glasgow	Glasgow	Glasgow
Commanders	William Grierson	John Carnaghan	....	James Hendry	Richard Soden	Henry M'Millan	William Watson	James Stobo	Robert Adair	David Jopping
Wrecked, &c.*	....	....	*	....	....	....	....	*	....	....
Average Cargo in Tons	730	870	840	890	900	1150	1160	1400	1400	1400

Glasgow to Calcutta, distance per Chart, 12,743 miles. In sailing the voyage

FOR A NEW PADDLE WHEEL PASSENGER SHIP. Dated November 21st, 1860.

Particulars.	Richardson and Duck, Tyne.	Day & Co., Southampton.	W. C. Miller, Liverpool.	Jackson and Watkins.	J. C. Mare, London.	Scott Russell, London.	Scott, Sinclair, ond Co., Greenock.	Mitchell, Newcastle-on-Tyne.
Keel	No keel	$5 \times 1\frac{1}{8}$	No keel	$6 \times 1 \times \frac{3}{4}$	No keel	No keel	No keel	$6 \times 1\frac{3}{4}$
Keel Plating	$\frac{11}{16}$	…	$\frac{5}{8}$ to $\frac{9}{16}$	…	$\frac{1}{2}$ plate	…	$\frac{3}{4}$ plate	…
Stem	$6\frac{1}{2} \times 2$	$5 \times 1\frac{5}{8}$	6×1	$6 \times 1 \times \frac{3}{4}$	No satisfactory	6×1	No particulars	$6 \times 1\frac{3}{4}$
Stern Post	$6\frac{1}{2} \times 2$	5×2	$6 \times 2\frac{1}{2}$	$6 \times 1 \times \frac{3}{4}$	particulars	6×3	,,	$6 \times 1\frac{3}{4}$
Frames Midship	$3\frac{1}{2} \times 3 \times \frac{7}{16}$	$4 \times 3 \times \frac{7}{16}$*	$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	$4 \times 3 \times \frac{3}{8}$	$3 \times 2\frac{1}{2} \times \frac{3}{4}$	3×3	$3\frac{1}{2} \times 3 \times \frac{3}{8}$	$4 \times 3\frac{3}{8}$
,, Space	18	18	18	18	18	24	18	18
,, Fore and Aft	$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	None given	$3 \times 2\frac{1}{2} \times \frac{3}{8}$	$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	$3 \times 2\frac{1}{2} \times \frac{3}{4}$	No particulars	$3 \times 2\frac{1}{2} \times \frac{5}{16}$	$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$
,, Space	18	…	26	18	18		21	18
,, Reverse	$3 \times 2\frac{1}{2} \times \frac{3}{8}$	$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	$3\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$	None given	$2\frac{1}{2} \times 2 \times \frac{5}{16}$	,,	$2\frac{1}{4} \times 2\frac{1}{4}$	Nil
,, Floors	$12\frac{1}{2} \times \frac{7}{16}$	$11 \times \frac{7}{16}$	$10 \times \frac{3}{8}$	$15 \times \frac{3}{8}$	$12 \times \frac{3}{8}$	,,	$12 \times \frac{1}{4}$	$15 \times \frac{3}{8}$
Keelsons	$4\frac{1}{2} \times 3 \times \frac{7}{16}$	$11 \times \frac{7}{16}$	…	$5 \times 3 \times \frac{3}{8}$	$4 \times 3 \times \frac{3}{8}$	,,	$4 \times 3 \times \frac{3}{8}$	$5 \times 3 \times \frac{3}{8}$
Beams	$6 \times \frac{7}{16}$	$6\frac{1}{2} \times \frac{7}{16}$	$5 \times \frac{5}{16}$	$6 \times \frac{3}{8}$	$6 \times \frac{3}{8}$	6	$5 \times 3 \times \frac{5}{16}$	$6 \times \frac{3}{8}$
,, Angle Irons	Nil	$2\frac{1}{2}$	$2 \times 2\frac{1}{2} \times \frac{1}{4}$	$2\frac{1}{4} \times \frac{5}{16}$	$2\frac{1}{2} \times 2 \times \frac{5}{16}$	No particulars	No particulars	$2\frac{1}{2} \times 2\frac{1}{4} \times \frac{5}{16}$
Bulkheads	6 in No. $\frac{3}{8} \times \frac{5}{16}$	According	4 in No. $\frac{3}{8}$ to $\frac{1}{4}$	According to	According to	3 in No. $\frac{5}{16}$ to $\frac{1}{4}$	According to	According to
,, Angle Irons	$3 \times 2\frac{1}{2}$	to Bd. of T.	$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$	Bd. of Trade	Bd. of Trade	3×3	Board of Trade	Board of Trade
Stringers	$21 \times \frac{7}{16}$	$18 \times \frac{7}{16}$	$15 \times \frac{5}{16}$	$24 \times \frac{7}{16}$	$18 \times \frac{3}{8}$	Longitudinal	$21 \times \frac{3}{8}$	$15 \times \frac{3}{8}$
,, Angle Iron	$4\frac{1}{2} \times 3 \times \frac{7}{16}$	$3 \times 3 \times \frac{3}{8}$	$3 \times 3 \times \frac{3}{8}$	…	$4 \times 3 \times \frac{3}{8}$	web is adopted	3×3	$3\frac{1}{2}$
Floating Garboard	$\frac{5}{8} \times \frac{9}{16}$	$\frac{5}{8}$ to $\frac{1}{2}$	$\frac{5}{8}$ to $\frac{9}{16}$	$\frac{5}{8}$ to $\frac{9}{16}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{9}{16}$ to $\frac{3}{8}$	$\frac{5}{8}$ to $\frac{9}{16}$
Bottom ditto	$\frac{1}{2} \times \frac{7}{16}$	$\frac{9}{16}$ to $\frac{7}{16}$	$\frac{3}{8}$ to $\frac{5}{16}$	$\frac{1}{2}$ to $\frac{7}{16}$	$\frac{7}{16}$	$\frac{5}{8}$	$\frac{7}{16}$ to $\frac{5}{16}$	$\frac{1}{2}$ to $\frac{7}{16}$
Bilge ditto	$\frac{1}{2} \times \frac{7}{16}$	$\frac{3}{8}$	$\frac{5}{16}$ to $\frac{1}{4}$	$\frac{7}{16}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{8}$ to $\frac{1}{4}$	$\frac{7}{16}$ to $\frac{3}{8}$
Shear Streak ditto	$\frac{1}{2}$	$\frac{9}{16}$ to $\frac{1}{2}$	$\frac{9}{16}$ to $\frac{7}{16}$	$\frac{1}{2} \times \frac{7}{16}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{7}{16}$ to $\frac{5}{16}$	$\frac{1}{2}$ to $\frac{7}{16}$
Top Sides ditto	$\frac{7}{16} \times \frac{3}{8}$	$\frac{3}{8}$	$\frac{5}{16}$ to $\frac{1}{4}$	…	$\frac{3}{8}$	$\frac{1}{2}$	…	…
Riveting	Bottom and Butts d'ble	Butts only dbl.	Butts only dbl.	Butts only dbl.	Butts only dbl.	All single	Butts only dbl.	…
Draught of Water	…	…	…	…	…	…	…	…
Engine, Nominal H.P.	…	225 oscillating	…	…	…	Oscillating	Oscillating	…
,, Cylinders	D. 50½″ St. 60″	D. 58″, St. 54″	…	D. 58″ St. 45″	D. 57″, St. 52″	D. 55′ St. 60	D. 53′ St. 54′	D. 55′ St. 54
,, Wheels	23′ cen. to cen.	…	…	16′	19′ 6″	18′ × 3′	20′ 9″ over all	18′
,, Floats	…	…	…	8′ × 3′	3′ 6″ × 9′	9′ × 2′ 9″	7′ × 2′ 10″	…
Average Revolutions	…	…	…	37½	35	39	35 to 36	35 to 37
Boiler, Fire Grate Area	…	…	…	198	224	252	200	200
Total Heating Surface	4320	…	…	5150	4500 (?) 5500	4700	5000	5700
Tubes, Diameter	2¾	…	…	2½	2¾	2¾	2¾	…
,, Number	512	…	…	1220	1200	960	840	935
,, Length	7′	…	…	6′	6′	5′ 8″ to 5′ 9″	…	7′
Consumption of Fuel per hour	Not given	…	…	30 to 35 cwt.	40 cwt.	2½lbs. p. I.H.P.	40 cwt.	36 cwt.
Working Pressure	20lbs. pr 40lbs.	25lbs. pr 50lbs.	…	…	…	…	…	…
Number of Boilers	2 superheating	2	…	…	…	4	2	…
,, Furnaces	8	…	…	10	8	12	10	10
Length and Breadth of Furnaces	— to 3′ 4″	…	…	7′ × 2′ 10″	8′ × 3′ 6″	6′ 6″ × 3′ 3″	7′ 3″ × 2′ 9″	7′ × 2′ 10⅝″

* Dimished fore and aft.

NOTES FROM THE NORTH.

Monthly Line of Sailing Packets owned by Messrs. George Smith & Sons, Glasgow.

Names of Vessels	City of Delhi	City of Canton	City of Perth	City of Pekin	City of Lucknow	City of York	City of Madras	City of Nankin	City of Shanghai	City of Calcutta
Names of Builders	[Robert St	eele & Co.]	Barclay, Curle, & Co.	Barclay, Curle, & Co.	A. Stephen & Sons, Kelvinhaugh	Barclay, Curle, & Co. Stobcross	A. Stephen & Sons, Kelvinhaugh	Barclay, Curle, & Co.	Barclay, Curle, & Co.	A. Stephen & Sons, Kelvinhaugh
Where Built	Greenock	Cartsdyke	Stobcross	Glasgow	Glasgow	Glasgow	Glasgow	Stobcross	Glasgow	Glasgow
Date of Launching	1856, March 31	1857, August 7	1857, Aug. 19	1858, Jan. 15	1859, March 5	1859, June 4	1859, Sept. 28	1859, October 8	1860, October 18	1860, Nov. 4
Length of Keel and Forerake (Builders' Measurement)	173ft. 4in.	191ft.	150ft.	190ft.	192ft. 0in.	155ft. 0in.	200ft.	200ft.	200ft.	200ft.
Breadth of Beam	31 8	31	27	31	30 6	29 3	32	32	32	32
Tonnage (Customs Measurement)	$823\frac{19}{94}$	$881\frac{24}{94}$	$527\frac{23}{94}$	$875\frac{76}{94}$	$858\frac{23}{94}$	$625\cdot\frac{10}{94}$	$984\frac{48}{94}$	$984\frac{48}{94}$	$984\frac{48}{94}$	$984\frac{48}{94}$
Length—Fore part of Stem to after part of Stern-post	178·7	197·4	151·6	196·9	200·6	156·0	209·0	212·2	212·6	211·2
Breadth, extreme	31·9	31·2	27·3	31·2	30·6	29·25	32·0	32·3	32·35	32·0
Depth of Hold, amidships	21·85	20·8	18·0	20·85	21·55	19·25	21·9	21·45	21·5	21·75
Tonnage, under deck	812·75	853·30	458·56	839·81	843·62	569·25	953·53	952·60	953·11	950·01
Poop or Break	…	55·39	…	53·58	45·18	…	45·83	33·53	36·61	33·94
Register (gross)	812·75	908·69	458·56	893·39	888·80	569·25	999·35	986·13	989·72	983·95
Figure-head	Demi Fem.	Demi Male	Demi Fem.	Demi Male	Demi Fem.	Demi Fem.	Demi Male	Demi Male	Demi Male	Demi Fem.
Galleries	None	None	None	None	None	None	Sham	None	None	None
Stem	Common	Clipper	Clipper	Clipper	Clipper	Common	Clipper	Clipper	Clipper	Clipper
Stern	Square	Square	Square	Elliptic	Elliptic	Square	Elliptic	Square	Square	Round
Decks	2	2	1	2	2	1	2	2	2	2
Bowsprit	Standing	Standing	Standing	Standing	Standing	Standing	Standing	Standing	Standing	Standing
Masts	3	3	3	3	3	3	3	3	3	3
Rigged	Ship	Ship	Ship	Ship	Ship	Ship	Ship	Ship	Ship	Ship
Bulkheads	…	2	…	4	3	…	3	4	4	4
Classed A 1 at Lloyds (years)	13	12	10	12	13	10	13	12	12	13
Material built of	Wood	Iron	Wood	Iron	Iron	Wood	Iron	Iron	Iron	Iron
Port of	Glasgow	Glasgow	Glasgow	Glasgow	Glasgow	Glasgow	Glasgow	Glasgow	Glasgow	Glasgow
Commanders	David Muir	John Blair	William Robertson	James Stobo	Francis Brown	Charles Connell	William Connell	George Craig	John Smith	John Dick
Wrecked, &c.*	…	…	…	…	*	…	…	…	…	…
Average Cargo in Tons	1400	1450	890	1450	1500	1000	1500	1500	1500	1500

is from 13,000 to 14,000 miles. The voyage extending from 90 to 120 days, generally.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties,' we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

KRUPP'S STEEL WORKS.—Mr. Bessemer has supplied plans of his apparatus for converting pig-iron directly into steel to Herr Krupp, for erection at his works at Essen. From what is known of the working of the Bessemer process upon the manganesian ores of Prussia, it is altogether probable that Herr Krupp's entire manufacture of steel will ultimately be produced without resorting either to puddling or cementing. Herr Krupp is about erecting a plate-mill, the standards of which are to be 15ft. apart, so as to roll plates 14ft. wide, thus enabling the barrel of a locomotive boiler to be rolled in a single plate. Messrs. Caird and Co., of Greenock, are about receiving from Essen a cast-steel crank weighing 15 tons. Krupp is now executing an order for 250,000 steel rifle barrels for Russia, the barrels to be made solid, and afterwards bored out. The same maker will exhibit a 250-pounder rifled cannon in the coming Exhibition.

TEST OF WIRE-ROPE.—Some tests have recently been made at the Liverpool Corporation machine, under the superintendence of Mr. W. M'Donald, with the view of testing the strength of the charcoal rope supplied by Messrs. Whaley, Burrows, and Fenton for the shrouds of the *Contest*. The ropes tested were a 5in. rope by Messrs. Newall and Co., which broke at 34 tons 10 cwts.; and a 5in. rope by Messrs. Whaley and Co., which broke at the back of the thimble, though not in a nip, at 25 tons. Both ropes were thus above the Admiralty test, yet neither appear to have been equal to the ropes of Messrs. A. J. Hutchings and Co. and Messrs. Garnock, Bibby, and Co.: a 4½ inch rope by the former makers having borne 37 tons 15 cwts., and a 4½in. rope of the latter 26 tons 10 cwts.

FRENCH GOVERNMENT POSTAL CONTRACT.—A contract has been entered into by the French Government with the Compagnie Générale Maritime for the establishment of a postal steam service monthly between France, the Island of Martinique, Santiago de Cuba, and Mexico. The speed at which this service is to be performed is nine knots per hour, and the subsidy granted is at the rate of 21*s.* 11*d.* per mile. This contrasts strikingly with the rates paid by the British Government to the contract packet companies generally. For example, the Royal Mail Steam Packet Company, which conveys the mails between this country and Mexico, although required to perform the service at a much higher rate of speed, is paid less than 10s. per mile.

BULLION.—According to a return lately issued, the bullion purchased by the Bank of England last year in gold amounted to £11,790,095, and in silver to £411,101. The gold bullion sold by the Bank was £693,102, and the silver £1,824,928. Respecting British gold coin, it appears that the excess of payments was £7,139,088; the excess of receipts, £437,452. The sum received from the Mint was £8,186,310.

THE POST-OFFICE PACKET SERVICE.—From an estimate given in a Parliamentary paper it appeared that in the year 1862-63 the whole charge for the Post-office department packet service is £915,897, against £994,956 of the preceding year.

HIS ROYAL HIGHNESS THE PRINCE OF WALES arrived in Alexandria Harbour at 9.45 A.M., March 1st, and at once proceeded to the railway station, where a special train was awaiting him. The train left Alexandria at 12 (noon), reaching Kafr Laïs (distance 64 miles), at 1·45 P.M. Mr. W. J. Hardcastle, the Resident Engineer of the Alexandria portion of the line, having taken his leave, and Mr. William Parry, the Resident Engineer of the Cairo division, joined the party, the train left Kafr Laïs at 3·10 P.M., and reached Cairo (distance 66 miles) at 4·25 P.M. The train slackened speed through all intermediate stations, and during this portion of the journey the speed reached sixty miles an hour, the train showing the greatest steadiness. The road is laid on cast iron bells (Greaves's Patent). The state carriage in which H.R.H. made the journey, and the attached fine locomotive engine, both of which drew marked admiration, were built for the special service of His Highness the Viceroy, by Messrs. Robert Stephenson and Co., of Newcastle-on-Tyne. Mr. Robert Jeffrey, the Locomotive Superintendent, had charge of the engine throughout the journey.

IMPROVED MODES OF TRANSIT ACROSS THE MERSEY.—The new engineer of the Mersey Dock estate, Mr. Lister, has inaugurated his appointment by several improved plans for the goods and passenger traffic in connection with the Birkenhead ferries. One of these improvements consists in the adoption of a new class of steamers, similar to those employed on the Hudson at New York, and by which loaded vehicles, and other descriptions of traffic, may be driven on board at one end of the boat and out at the other, without the slightest inconvenience, and without turning. The passage across the river under these circumstances will be almost as convenient as it would be by a bridge over the river. The new boats are also to be specially adapted for passengers by the erection of promenade decks, and deck saloons enclosed with glass. Mr. Lister's plans have been brought before the Birkenhead commissioners, and were most warmly applauded. The Woodside ferry is becoming a most valuable property to the township, and as an instance of the capital producing capabilities of the said ferry, the following statement of accounts may be quoted:—"During the ten months ending 28th February of this year the receipts were £26,584 against £22,940 compared with a period of the same duration in the twelve months before. The expenditure during the former period was £19,303, leaving a clear gain to the township of £7,200."

THE GOVERNMENT BILL ON WORKS OF ART.—The following are the principal features of the bill introduced by the government for amending the law relating to copyright in works of the fine arts, and for repressing the commission of fraud in the production and sale of such works. The preample states that by law, as now established, the authors of paintings, drawings, and photographs, have no copyright in such their works, and it is considered that it is "expedient" that the law should be amended. By the bill, it is proposed to enact that the author of every painting, drawing, and photograph which shall be made, or for the first time sold, or disposed of, either in the British dominions or elsewhere after the commencement of the act, is to have the vested right for his life, and his assigns for seven years after his death. All copyright under the new law is to be considered personal or moveable estate, and every licence to use the same to be in writing. To secure copyright from infringement, penalties are provided. Parties may be proceeded against by action or before magistrates. The former remedy would be expensive, and the offence might be continued without the expense of an injunction. The penalty is £10, or not exceeding double the full price at which the work was offered for sale, whether copyright or not. All importation of pirated works is prohibited, and such copies may be seized by the customs. Actions may be brought for damages by proprietors against persons who shall copy or imitate their works.

THE ROAD APPROACHES TO THE INTERNATIONAL EXHIBITION.—On the 10th ult. Messrs. Mowlem, Burt, and Freeman, of Grosvenor-wharf, Westminster, set to work a large body of men employed by them to reconstruct the road approaches to the Exhibition building, the firm having arranged with the commissioners to have the whole completed by the 1st of May. The surface to be covered is 50,000 square yards (super.), and it will take from 12,000 to 14,000 tons of material to make the roads good, the whole of which will have to be carted, spread, rolled, and consolidated by the date fixed for the opening of the Exhibition.

FAILURE OF THE RUGBY SANITARY ENTERPRISE.—The Rugby Board of Health have been seriously embarrassed by the discovery that the plan which it has pursued for four years, and upon which it has spent £4000, for supplying the town with water, has irremediably failed. The boring of the well had reached the water bearing strata of the new red sandstone, when it was found that it had also reached a deposit of rock-salt, tht existence of which was wholly unsuspected, and the salt dissolving in the water broughe up by the bore hole, communicates to it a degree of brackish salinity which renders it totally unfit for food, or domestic use. From an analysis of samples it appears that the salinity has steadily increased, until in the last specimen there were found 1256 grains of saline matter in the gallon of water. Of these 777 grains consisted of chloride of sodium, the remaining constituents being principally sulphate of soda and sulphate of magnesia, with a small proportion of carbonate of lime, and traces of bromine, iodine, and lithium.

POSTAL SERVICE.—The railways of the United Kingdom are to receive from the Post Office £558,891 for carrying the letters this year; mail coaches £13,509. Carts, stage coaches, and omnibuses will, however, get no less than £124,910. The whole cost of the conveyance of mails this year in the United Kingdom is taken at £755,980. The packet service for the year will cost £900,000.

SMOKE AND NOXIOUS VAPOUR RESPIRATOR.—At the chain cable and anchor works, belonging to Messrs. Brown, Lennox, and Co., Millwall, experiments were recently made for the purpose of testing Bradbook's smoke and noxious vapour respirator. The whole of the persons present took part in the experiments. In an iron fire-proof oven, about the sive of an ordinary room, a large charcoal fire was made, which was fed for some time with paraffine oil, turpentine, assafœtida, gas tar, and wet straw, when a dense and suffocating smoke was produced. Several gentlemen, and the whole of the escape men, with the respirator in their mouths, then entered the oven. They remained in it for a period of 13½ minutes. In addition to the above ingredients a large quantity of sublimate of copper, a deadly poison, was also put upon the furnaces, and yet all the persons in the oven were enabled to breathe, without the least difficulty. The only inconvenience they experienced arose from the excessive heat. The apparatus is exceedingly light, and anyone wearing it can speak freely without the least danger of inhaling either heated smoke or noxious vapours.

We hear that Mr. Charles Atherton, Chief Engineer at her Majesty's Dock Yard, Woolwich, is about to leave the Service, and has resigned the highly responsible appointment which he has so creditably held for many years.

We understand that Mr. Taplin has also just resigned his appointment.

NAVAL ENGINEERING.

THE COST OF THE WARRIOR.—The total cost of the *Warrior*, before being ready for sea, was £354,885. The hull was £251,646; the engines, £71,875; masts and rigging, £18,536; and fittings and alterations, £12,828. This does not include the cost of her armament, £13,000 more.

GETTING UP STEAM.—A series of experiments have been carried out on board several of the screw gunboats belonging to the steam reserve at Chatham, by direction of the Admiralty, for the purposes of ascertaining the comparative advantages of wood and coal as fuel in getting up steam. The object more particularly kept in view was to ascertain whether, in the event of a fleet of gunboats being suddenly despatched to the Canadian lakes, wood is likely to prove more economical than coal. The result of the trials, so far as they have been carried, has been in the highest degree satisfactory. It has been ascertained that, in using the ordinary pitch pine-wood which abounds in Canada, steam can be generated in the boilers in about half the time necessary when coal alone is used.

THE "RATTLESNAKE," 21, was taken outside Plymouth brackwater, on the 13th ult., for the purpose of trying her engines. They are horizontal direct, of 400 H.P. nominal, anp where built by Messrs. Ravenhill, Salkeld, and Co. She is fitted with a Griffiths screw of 16ft. diameter, and 21ft. pitch. After running six times over the measured mile, with full power, a mean speed of 12·24 knots was produced; mean revolutions, 66 per minute. The *Rattlesnake* is masted and rigged complete, and draws 16ft. 4in. forward, 19ft. 6in. aft. When tried at the measured mile at Maplin Sands, December 21st, 1861, an average of six runs produced a mean speed of 13·023 knots. She then drew 13ft. 2in. forward, and 17ft aft.

THE "DEFENCE," 600 horse-power, 3,668 tons, and mounting 18 guns, made her official trial of speed, at the measured mile, in Stokes Bay on the 1st ult. The following are the results of the six runs made:—1st run, mean time 3 minutes, 47 seconds; speed in knots 12·543; revolutions of engines 67½; 2nd run, mean time, 6 minutes, 15 seconds; speed in knots 9·600; revolutions of engines 65¾; 3rd run, mean time, 4 minutes, 33 seconds; speed in knots 13·186; revolutions of engines 67½; 4th run, mean time, 6 minutes, 24 seconds; speed in knots 9·375; revolutions of engines 68; 5th run, mean time, 4 minutes, 25 seconds; speed in knots 13·584; revolutions of engines 67; 6th run, mean time, 6 minutes, 24 seconds; speed in knots 9,375; revolutions of engines 68. First means: 11·071, 11·393, 11·282, 11·480, 11·479; second means: 11·232, 11·338, 11·381, 11·480. True mean speed, in knots 11·357. During the trial the *Defence* had a heavy breeze from E.N.E., and troubled water. At the close of the runs at the measured mile the ship was laid fair for Spithead, and, when in a fit position, the helm was put hard-a-port, and a complete circle made in 6 minutes, 30 seconds, and, with the helm contrary way in 7 minutes, 6 seconds, the time being taken in both instances not before the ship felt her helm. The speed of the ship while making the circles, with the helm hard over, was, by ship's log 9 knots. The draught of water was aft, 25ft. 4in.; forward 24ft. 4in The pressure of steam was 20lb.; vacuum, 24in. The propellor was an improved Griffith's, with a diameter of 18ft., and a pitch of 21ft. On the 13th ult, the *Defence* made her second trial of speed at the measured mile in Stokes Bay. The weather was favourable for the trial, though at times thick. The wind was light at W.N.W. The ship's draught of water was nearly the same as on her former trial, being 25ft. 5in. aft, and 24ft. 3in. forward. She was complete in her stores and had 440 tons of coal on board. The ship's trial at full power showed a mean speed of 11·612 knots per hour; thick weather again setting in prevented the trials at half-boiler power. The ship was then taken off into deep water, and tested in going round the circle, which she accomplished in 8 minutes 10 seconds. In testing the Engines they were stopped, from the time of moving the telegraph on the bridge, in 12 seconds, started ahead in 15 seconds, and astern in 11 seconds. The temperatures on deck and below were as follows:—on deck, from 45 to 49 degrees; in the middle of the engine room, from 90 to 100 degrees; and in the stoke holes, from 88 to 96 degrees. The speed made on the first trial was 11·357, and that made on the present occasion 11·612, a quarter of a knot less than had been anticipated. The steering qualities of the vessel were found to be very uncertain. The half boiler speed trial of this vessel took place on the 15th ult., at the measured mile, in Stokes Bay. Six runs were made over the trial ground, the average of which gave a mean speed of nine knots. This trial concluded the testing of the speed of the *Defence*.

THE "RESISTANCE," iron-clad frigate, will be barque-rigged, like the *Defence*, and she will also be fitted with Cunningham's patent topsail yards. She will be provided with four of the 110-pounder (late 100-pounder) Armstrongs, and 10 68-pounder 25 cwt. smooth-bore guns on her main deck; and on her spar deck two 110-pounder Armstrong pivot guns, two 40-pounder Armstrongs, and two 32-pounder cast-iron guns.

THE "ROYAL OAK."—The Lords of the Admiralty have decided on having this armour-plated screw frigate supplied with iron lower masts and bowsprit, which will be manufactured for her at one of the private establishments. The *Royal Oak* is expected to be the first of the new armour-plated ships which will be afloat.

NAVAL APPOINTMENTS.—The following appointments have taken place since our last: J. Gray, Engineer, R. E. Denison, First-class, and J. Pardie, Second-class Assist. Engineers, to the *Petrel;* P. Colquhoun and J. M'Millard, Acting Second-class Assist. Engineers, to the *Cumberland* as supernumeraries; W. Edwards, Acting Second-class Assist. Engineer, to the *Indus;* R. Ditchburn and J. C. Taylor, late of the *Conqueror;* H. Peters and Blearr, Supernumeraries, in the *Indus;* J. Daly, in the *Desperate*, T. Bramley, in the *Hogue*, E. J. Murphy, in the *Firebrand*, J. Ankers, in the *Edinburgh*, and A. Purves, in the *Bulldog*, promoted from Second-class to First-class Assist. Engineers; J. Lamout, Chief Engineer, to the *Asia*, for charge of *Simoon;* H. Brown and T. McFarlane, Second-class Assist. Engineers, confirmed in the *Dauntless* and *Princess Charlotte;* C. P. Turner, Chief Engineer, F. T. Pendleton, and J. Scott, First-class Assist. Engineers, and W. Lawson, Second-class Assist. Engineer, to the *Styx;* J. Duffield, First-class Assist. Engineer, to the *Shannon*, vice Webber; W. W. Webber, to the *Asia*, as supernumerary, for hospital treatment; J. Knight, in the *Hero*, promoted to Acting First-class Assist. Engineer; J. Frazer, confirmed as Second-class Assist. Engineer in the *Virago;* J. W. Watson, Acting Second-class Assist. Engineer, to the *Indus*, as supernumerary; J. G. Sampson and W. F. Cole, Second-class Assist. Engineers, to the *Indus*, as supernumeraries; H. W. Blake, Chief Engineer, and J. Langlands, Engineer, to the *Indus*, for the *Buzzard* and *Shearwater*, respectively; J. Barlow, Second-class Assist. Engineer, confirmed in the *Asia;* W. Jones, Second-class Assist. Engineer, confirmed in the *Warrior;* W. B. Stephens, Engineer, W. H. Bambury, First-class Assist. Engineer, and H. T. Smeddle, Acting Second-class Assist. Engineer, to the *Dart;* J. Jeans and R. H. Dobney, First-class Assist. Engineers, to the *Asia*, for the *Swinger* and the *Savage*, respectively; H. Binck, First-class Assist. Engineer, to the *Hawke*, for the *Lark;* W. McLaurin, Acting First-class Assist. Engineer, to the *Euryalus;* J. C. Grachy, and J. Ashley, promoted to Chief Engineers; J. Conolly, and J. Jaurie, confirmed as Second-class Assist. Engineers in the *Indus* and *Simoon*, respectively; J. Radford, and G. J. Maybary, Acting Second-class Assist. Engineers, to the *Cumberland;* J. Dows, comfirmed Second-class Assistant Engineer, in the *Virago;* R. J. Wilson, Chief Engineer, J. T. Harris, Engineer, C. H. Pillar, First-class Assist. Engineer, to the *Magicienne;* J. A. Wilson, Engineer, H. Peters, First-class Assist. Engineer, and R. Macaulay, Acting Second-class Assist. Engineer, to the *Lee;* T. E. Buckle, Engineer, to the *Cumberland*, for the *Mullet;* B. Barber, Chief Engineer, J. Fox, Acting Engineer, R. Ockenden, First-class Assist. Engineer, and J. Smith, Acting Second-class Assist. Engineers to the *Tribune;* D. McFarlane, Engineer, supernumerary, and W. Fedarb, First-class Assist. Engineer, supernumerary, to the *Indus;* G. E. Stell, Second-class Assist. Engineer, invalided; J. Brough, Acting Second-class Assist. Engineer, to the *Odin;* J. Tillard, Chief Engineer, to the *Fisgard*, additional for the *Adventure;* T. G. Slade, promoted to Chief Engineer; H. Cooper, to the *Cumberland*, for the *Rattler;* W. Thomas, confirmed as First-class Assist. Engineer, in the *Fox;* E. Judge, promoted to Acting First-class Assist. Engineer, in the *Falcon;* C. Hill, J. Franklin, and R. B. Nicholson, comfirmed as Second-class Assist. Engineer, in the *Kestrel*, *Melpomene*, and the *Nile*, respectively; J. Green and T. S. Lunt, Acting Second-class Assist. Engineers, to the *Cumberland* and *Asia*, as supernumeraries; T. E. Buckle, Engineer, to the *Mullet;* J. Lanksburg, Acting First-class Assistant Engineer, to the *Mullet;* John Simpson, Acting First-class Assistant Engineer, to the *Royal Adelaide*, for the *Cuckoo;* J. B. E. Warrington, Acting Second-class Assistant Engineer; W. E. Presgrave, to the *Indus;* James Clark, to the *Bulldog;* John Hancock (A), to the *Emerald;* Thomas Rose, to the *Gannet;* Reignald C. Oldknow, to the *Edgar*, First-class Assistant Engineers (promoted); Thomas Barnes, to the *Chameleon;* S. R. Brumage, to the *Doris;* George Simpson, to the *Asia;* R. H. Trubshaw, to the *Cadmus*, Acting First-class Assistant Engineers (promoted); James M'Graw, Second-class Assistant Engineer (confirmed), to the *Centaur*.

THE "RESISTANCE."—The contractor's trial of this vessel at light draught of water, took place at Sheerness on the 19th ult. The *Resistance* is sister ship to the *Defence*, and is of 600 horse-power, 3668 tons, and will carry 18 guns. She was built by Messrs. Westwood, Baillie, and Co., launched in April, 1861, her engines being constructed by Messrs. John Penn, and Son. The following are the results of the trial:—Average speed, with full boiler power, 12·331 knots; pressure of steam, 20; revolutions, 70; vacuum, 25 to 26; average speed, with half boiler power, 11·394 knots; pressure of steam, 20; revolutions, 64; vacuum, 26. The circle was accomplished in 7 min. 25 sec., the diameter of the circle being about 300 yards. The engines were stopped dead in 4 sec., started ahead in 5 sec., and turned from their position astern in 4 sec. Draught of water forward, 19ft. 9in; aft, 23ft. 6in.; Griffith's screw, pitch, 21ft. The average temperatures during the trial were—engine-room, 97; after stoke hole, 100; fore stoke hole, 80; on deck, 47. These results have been accomplished with a velocity of piston rod of upwards of 500ft. per minute, and this, too, with a smoothness of motion and entire absence of vibration noticed by all on board. The *Resistance* answered her helm in a very satisfactory manner.

THE "ARETHUSA," 51.—On the 22nd ult., a preliminary trial of this screw steam frigate, took place at Sheerness. This vessel was built about 17 years ago, as a sailing frigate, but as since been converted into a screw frigate. The alterations which she has undergone consist in her being lengthened amidships 41ft., and having had her stern altered and lenthened 12ft., to adapt her for the screw. Her bow still retains her original bluff form. The extreme length of the vessel between perpendiculars is now 252ft.; length of keel for tonnage, 217ft.; extreme breadth, 52ft. 8in; ditto for tonnage, 52ft. 2in.; depth of hold, 17ft. 1in.; burden, 3142 tons. The *Arethusa* is fitted with a pair of expansive trunk engines by (Messrs. John Penn and Sons), of 500 horse-power, with two cylinders, 86½in. diameter, the trunk being 33in. diameter, and the length of stroke 42in., with surface condensers containing nearly six miles of one inch tubing. The boilers, four in number, with four furnaces to each, are fitted with superheating apparatus. The propeller is Griffith's, pitch 20 to 26ft., present pitch, 23ft. The performance of the machinery during the trial was most satisfactory both as to the working of the engines and the results produced. It being late before the *Arethusa* reached the measured mile it was found impossible to satisfactorily complete the trial on the 22nd ult., consequently four runs only were made, the average results of which were 12·654 knots; pressure of steam, 24; revolutions, 63; vacumm, 28½. The force of wind during the time was from 5 to 6. The circle was turned in 6 minutes, the diameter of circle about five times the length of vessel. The average temperatures during the day were—engine-room, 54 deg.; fore stoke hole, 83 deg; after stoke hole, 87 deg.

THE "ROYALIST."—The official trial of the engines and machinery of this steam sloop recently took place at Plymouth. The *Royalist* was launched last year at Devonport, measures 686 tons, and was intended to carry 11 guns, but in consequence of recent Admiralty regulations, will not carry so many. Her engines, a pair of 150 horse-power, collectively, are from the Greenock Foundry. They are horizontal direct-acting; cylinders, 38in.; stroke, 2ft.; and can be worked up to about 650 horses. The shaft is 65ft. long; the propeller, Griffiths, is of 10ft. diameter, with a pitch of 13ft. The *Royalist*, which is not masted, draws 9ft. 8in. forward, and 12ft. 4in. aft. The wind was strong from the eastward. Six runs at the measured mile under full power produced an average speed of a little more than 11 knots; revolutions per minute, 106; pressure, over 20lb.; vacuum, 26½in.

THE "ALBION," 80.—The contractor's trial of the engines of this vessel took place on the 21st ult., at Plymouth. Her engines, by Messrs. Humphreys, Tennant and Co., are of 400 horse power. They are horizontal, direct-acting, exceedingly simple and compact, and any part can be approached while they are in motion. The screw shaft is 90ft. long by 12¾in. in diameter, the diameter of the screw is 17ft., and the pitch, 19ft. The draught of the ship forward is 18ft. 9in., and aft, 21ft. 6in. The average speed attained, with full boiler power, after six runs at the measured mile, was 11 knots; revolutions, 69 per minute; pressure, 20lb.; vacuum, 27in.; half boiler power, 8·87 knots; revolutions, 54.

THE "AURORA," 51.—The official trial of the engines of this screw steam frigate took place on the 14th ult., outside Plymouth Breakwater. The *Aurora* measures 2558 tons, and her dimensions are as follows:—Length between perpendiculars, 227ft.; length for tonnage, 196ft. 8in.; breadth, extreme, 50ft.; ditto for tonnage, 49ft. 6in.; ditto, moulded, 48ft. 8in.; depth of hold, 16ft. 9in. Her engines are horizontal direct-acting, of 400 H.P. nominal, by Messrs. Maudslay, Sons, and Co., contracted for in 1854. They are fitted with double-ported slides, like those in the *Defiance* and *Gibraltar*. The screw-shaft which is 94ft. 6in. long by 12¼in. diameter, is in four pieces. The *Aurora* has been fitted with the late Mr. J. Maudslay's patent propeller with feathering blades. It permits of the pitch of the propeller being changed while the engines are in motion. The diameter of the screw is 17ft. The finest pitch is 17ft. 6in., from which position the blades can be turned till they are parallel with the keel, fore and aft, or in a line with what is termed the "dead wood," where, while motionless, it will not affect the direction or retard the movement of the ship, or the action of the rudder. On this occasion the screw was set at 22ft. 6in., and so continued. The *Aurora* draws 16ft. 9in. forward, and 19ft. 7in. aft. The wind was from the eastward, with a force of 4 to 5. The mean rate attained in four runs under full speed, was 11·35 knots per hour; and of two runs under half boiler, 8 knots. In the first trial the revolutions averaged 61 per minute; pressure of steam, 20lb.; and the vacuum, 24in. In the second trial the revolutions averaged 45; pressure of steam, 20lb.; and vacuum, 25in.

STEAM SHIPPING.

A MEDIUM-SIZED PADDLE YACHT, intermediate between the *Victoria and Albert* and the *Fairy*, is about to be built for the use of her Majesty.

THE "CORTES," screw steamer, built by Messrs. Thomson of Govan, lately made a very satisfactory trip. This steamer, which is intended to ply between Cadiz and Havannah, is ship rigged, and her length of keel is 280ft., while her breadth of beam is 39ft., and her burden 2,100 tons. She is propelled by a lifting screw, driven by direct acting engines of 500 horse-power. At the trial trip these engines made 57 revolutions per minute, and a speed of 13¾ knots per hour was attained, although the screw was not completely immersed.

THE "COLON," sister ship to the *Cortes*, made a very satisfactory trial trip on the 1st ult. Her engines worked beautifully, making 54 revolutions per minute. The rate of speed ttained was equivalent to 13 or 13½ knots per hour.

THE "SCOTIA."—The trial trip of this new steamer for testing her efficiency and speed for the mail service (before leaving the Clyde for Liverpool), was highly satisfactory, notwithstanding the unpropitious state of the weather. The distances were performed under the following conditions:—Against a strong flood tide, and also against a double-reefed topsail, wind, from the Clock to Cumbræ Light in 59 minutes; after passing the Cumbræ, the *Scotia* was brought round with great ease, and performed the upward run, with wind and tide in her favour in 49 minutes; mean time 54 minutes. The following was the rate of speed:—

59 min. 13·898 knots, or 16·010 miles per hour.
49 min. 16·743 knots, or 19·277 miles per hour.
30·632 . 35·287

mean speed 15·316 knots, or 17·643 miles. It is anticipated that under ordinary circumstances the maximum speed of the *Scotia* will be about 19 miles per hour.

LAUNCHES OF STEAMERS.

LAUNCH OF THE SCREW STEAM VESSEL "RATTLER."—Her Majesty's screw steamship *Rattler*, of 17 guns, and 200 horse-power, was launched in a most successful manner on the 18th ult., from No. 3 building slip at Deptford Dockyard, under the superintendence of Mr. Henry L. Peake, master shipwright, and in the presence of several hundreds of spectators. She is ordered to be towed to Sheerness Dockyard, to be fitted with her engines and machinery, which are manufactured by Messrs. Maudslay and Co. Her dimensions are:—Length between perpendiculars, 210ft.; breadth, extreme, 32ft. 6in.; depth in hold, 17ft. 8in.; tonnage, 951.

CLYDE STEAMSHIP BUILDING.—Messrs. C. Connell and Co., of the Overnewton Shipbuilding Yard, have just launched an iron steamer for the Queensland Government. The steamer, which has been named the *Brisbane*, after the capital of the colony, is being engined by Messrs. A. and J. Inglis, Whitehall Foundry. Messrs. Connell have contracts remaining on hand to the extent of from £30,000 to £40,000. Messrs. W. Denny and Brothers, of Dumbarton, have completed six models of steamers, which they propose to show in the International Exhibition. The principal model in the collection refers to the *Hibernia*, one of the Montreal Ocean Steamship Company's fleet; this model is upwards of 6ft. in length, and is constructed so as to show, on one side, the exterior of the hull, and, on the other, the interior above the main deck. The *Rona*, built by Messrs. W. Denny and Brothers for Messrs. Jardine, Mathieson, and Co., has made a satisfactory trial trip, having "run the lights," a distance of 13¾ knots, one way in 65½ minutes, and back in 63 minutes. The *Rona*, which will leave in a few days for China, is of the following dimensions:—Length, 230ft.; beam, 33ft.; depth to spar deck, 21ft. 6in.; burden, 1,220 tons old measurement. At the trial trip her draught of water was 7ft. 6in. She has a pair of diagonal engines, the diameter of the cylinders being 46in., the stroke of the piston, 9ft., and the working pressure, 35lb.

RAILWAYS.

The Indian Branch Railway Company is the name of a new joint-stock undertaking recently announced. The proposed capital is £500,000, in 50,000 shares of £10 each. The directors are mostly connected with Eastern enterprise, and it is expected that the project will prove advantageous to the existing railway companies, and also to the trade of the empire. This is the first Indian railway established without a Government guarantee; but if, as is alleged, ample scope exists for the company's operations, there is no doubt that it will prove remunerative, especially as the Government undertake to deliver to the company the roadways perfectly constructed and ready to receive the rails, together with all the land necessary for sideways and stations, for a period of ninety-nine years, free of cost. The directors have determined upon giving their services gratuitously until dividends of five per cent. per annum shall be paid to the shareholders.

The Manchester, Sheffield and Lincolnshire Railway solicit power for establishing a station in Liverpool, in conjunction with their gradually extending system. It is proposed to construct a railway one mile and 53 chains in length, from a junction with the authorized line of the Garston or Liverpool railway, at Egerton-street, Toxteth-park, to or near the junction of Lawton [and Ranelagh-street, Liverpool. The proposed new line and station are to be completed, if authorized in five years.

The Great Western Railway Company's rolling mill at Swindon now produces from 250 to 300 tons of rails weekly. The same company now have 317 broad guage and 230 narrow guage locomotives, or 547 in all.

The London and North Western Company are about to expend £100,000 on additional rolling stock. The present stock of locomotives is 972, of which 46 were received during the last half year.

Canadian Railways.—From an official report issued by the Government of Canada it appears that in 1860, 1880 miles of railway were in operation, the cost having been on an average £10,000 per mile. One accident happened to every 5,551,907 miles traversed, and one passenger was killed to every 14,295,150 miles travelled. The average cost of fuel per mile run by the engines was 6*d*., and the repairs of engines involved a cost of 6·34*d*. per mile. The average speed of express trains, including stations, was 24·3 miles per hour, and between stations 29·5 miles per hour. The average number of cars in passenge, trains was 3·2, in mixed trains, 7·5; and in freight trains 11·6. The total number of per sons employed was 6606.

Railway Brakes.—Messrs. Edwards, of Coventry, propose to construct, and by suitable bearings attach to and under the floor of the carriage, connected with the usual buffers, or with the buffer-springs of the carriage, or otherwise, an apparatus which acts upon the shutting off the steam, or upon reversing the engine, or upon any other powerful arresting cause on the whole of the brakes fitted to such carriage, and the train is very speedily brought to a stand. After applying the power of the engine, or other means, and communicating back motion for the purpose of shunting on to a siding, or otherwise, the whole of the breaks become released, and cease to act or retard the motion of the carriage. The brake acts by pressure on the rim of the wheel in the usual way, and to each carriage any number of breaks, not exceeding the number of wheels, may be fitted. Each break is mounted on a bar, or on a set of straight springs, attached to, or fitted with, and working upon, an axle between that portion which acts on the wheel and its other end; they place this metal bar, or spring which carries the break, vertically, or nearly so. The axle is attached to the carriage by suitable bearings, causing the axle either to be a positive fixture, or allowing it a horizontal spring motion, as may be desired; the upper end of such bar, or spring, has a hole in which the end of the buffer-rod fits. To each buffer-rod they attach longitudinally along one of its sides three metal fittings, that next the buffer working on a pin fitted to a hole in it, the pin having a head, and being fixed at its other end through a slot in the buffer rod, and rendered fast by a screw nut, or other suitable fitting, capable of adjustment. The first metal fitting is attached at its other end by a joint to the second, and that to the third, somewhat similarly to the connection of three links of a watch-chain, so as to allow these three pieces to perform, when requisite, a peculiar horizontal motion. The central fitting has attached to its inner edge a projection, having a longitudinal slot, in which is a metal pin, whose motion (when acted upon by another portion of the apparatus) causes the three pieces to occupy a straight line, or, when requisite, to perform a lateral motion, the effect of which is to shorten their aggregate length. The third piece, and furthest from the buffer, has a slot along its centre, which works easily on suitable fittings, allowing, when the other pieces are moved by the pin referred to, an adjustable amount of longitudinal motion. By this arrangement, when the three pieces are in a straight line, the end of the third piece on the buffer being depressed or forced inwards to a certain extent (which extent is regulated by the attachment of the first piece), presses against the side near the upper end, and puts in motion the metal bar or spring carrying the break, bringing into action the break attached to the other end of the same, and continuing such action either as long as such buffer is depressed, or until motion is communicated to the three pieces by the action of the pin working in the slot attached to the second of them. In order to enable a carriage or train to be backed or shunted, it is requisite that on commencing such operation the brakes should cease to act; for this purpose they fasten in a suitable manner the pin working in the slot of the second piece to one of a set of slides and levers fitted to and under the floor of the carriage, which, when brought into action, moves the said pin and fittings, and so releases the break or breaks, in consequence of one of such levers becoming acted upon by one of the teeth of a small wheel fitted on to the axle of the wheel or wheels, equi-distant, or thereabouts, from each other, on which the breaks have acted. The difference of pressure of the breaks after the train has been brought to a stand, and the reversing of the direction in which the wheels rotate, enables them to effect such purpose as soon, or thereabouts, as back motion is communicated.

RAILWAY ACCIDENTS.

Accident to a Train on the Great Western Railway.—On the night of the 22nd ult. an accident, which presented great probability of proving very serious in its results, befel the down mail-trail from Paddington. The train proceeded safely as far as Reading, where it was due at a few minutes before ten o'clock, and continued its course until the cutting between Pangbourne and Goring stations was reached; but here the train by some means got off the line, and ran along the timbers for some distance, when the engine became deeply embedded in the earth so near the up-line that the train from Bristol actually struck the engine of the mail-train in passing. No person was injured.

Accident on the North Kent Railway.—An accident occurred on the North Kent Railway on the 20th ult., between Strood and Gravesend, attended with the death of one person and injury to several others. The train to which the accident occurred was the 3.10 p.m. up-train from Strood, which follows immediately after the express. The train was composed of seven carriages, consisting of two of the large saloon first class carriages, two seconds, and three thirds, together with the guard's break-van directly after the engine. The train left the Station within a minute of its proper time, its first stoppage being at Higham. After leaving that station it proceeded at a speed of between twenty and thirty miles an hour, when, from some cause, the engine left the metals, dragging nearly the whole of the carriages after it. The engine-driver immediately used his endeavours to stop the train, but the engine, after running a great number of yards, left the line and turned over on its left side, rolling down the bank into a deep ditch, dragging the guard's van and nearly all the carriages after it. The fireman jumped from the engine before it turned over, and escaped with only some trifling hurts. The driver appears to have remained on the engine until it turned over, and is very severely injured. The head guard, who occupied the break next to the tender, was found beneath the *débris* of the carriages frightfully injured, and expired almost immediately afterwards.

MILITARY ENGINEERING.

Mr. Fairbairns' Target: Experiments at Shoeburyness.—In a previous number of The Artizan a description of an iron target. built up to resemble a section of an iron frigate's side, and designed by Mr. Fairbairn, of Manchester, to show how the teak backing to armour plates might be dispensed with, and increased strength obtained by a combination of ironwork alone, was given. The experiments on this target took place at Shoeburyness on the 4th ult. This target was 20ft. long by 10ft. high, with a porthole in the centre. The two large plates going the length of the target above and below the port were each 20ft. long, 3ft. 4in. wide, and 4½in. thick. The plates on each side of the narrow port were only 9ft. long, but of the same width and thickness. The two large upper and lower plates were each secured by 15 2-inch bolts, fastened with powerful screw nuts at the back, and the two centre plates by eight bolts of a similar description. These plates were fastened to 1-inch wrought-iron plates, representing the skin of the ship, and behind each line of bolts were straps of wrought-iron 20ft. long by 9in. wide, and three-quarters of an inch thick. The entire mass was supported by ribs, representing the sides of a ship, 18in. deep and 18in. apart, made of ⅞in. plates, secured by angle irons 4in. by 4in., and three-quarters of an inch thick; while the back of the ribs was still further strengthened by four horizontal strips of wrought-iron, 12in. wide by half an inch thick. The armour plates were not wrought, but rolled by Messrs. Brown and Co., of Sheffield, and the tonguing and grooving by which the *Warrior's* plates are dovetailed together was not resorted to in this instance, the plates being planed flat at their edges, and entirely dependent on the bolts for keeping their places. The whole target was an admirable piece of workmanship, and outwardly seemed strong enough to resist anything. The guns, six in number, were placed at a distance of 200 yards from the target, and consisted of one 120 and three 100-pounder Armstrong guns, with two 68-pounder guns for solid shot. The first experiment made was with three 100-pounder Armstrongs, with 12lb. charges, and shells filled with sand, weighing 104lb. each; and with two 68-pounder guns, with 16lb. charge, and shells filled with sand, weighing 50lb. each. These five guns were fired at minute intervals, striking the target on the left-hand of the port, and sending the fragments of the broken missiles flying off with a terrific hum through the air. An examination after these five shots were fired showed that no less than eight of the main boltheads which secured the plates had given way. This was such a serious defection that it could only be accounted for by supposing that the screw nuts fastening the plates at the back of the target had been drawn up too tight. The nuts were accordingly slackened down, and a packing of lanyard put between the armour plates and screw nuts of many of the chief bolts, to deaden the concussion, and the trial was proceeded with. The same guns were again fired with the same charges, but this time with live shell, the Armstrongs having a bursting charge of 8lb., and the 68's a charge of 2lb., with pillar and concussion fuses. Each shell exploded with a tremendous crash, and four more of the armour plate bolts were broken at the back of the target, snapping off as short as if they were cast-steel. The indent made by the shells was not very much, though apparently more than was made by the same missiles on the hammered plates of the *Warrior* target, and on both the blows of the 68-pounders had told with a severity in proportion to the increased initial velocity of the smooth-bore over the Armstrong guns. Under this experiment one of the plates, which had been previously struck by the sand-shell on the left of the port, had buckled out about an inch and a quarter, and the whole appearance of the target showed that it could not stand long. The firing was then continued with one 120-pounder Armstrong, with a 20lb. charge and 140lb. solid shot, three 100-pounders, with 14lb. solid charge and 110lb. solid shot, and one solid 68-pounder. The result of this trial was almost conclusive. The 140-pounder struck with a terrific blow between the edges of the top and middle plates, making a deep dent. The second struck on precisely the same spot, deepening still further the dent, breaking the fibre of the iron, and cracking the top and middle plates up to the nearest bolt-heads. The third shot struck in the middle plate, but the fourth hit again exactly in the same spot where the first and second had gone before, and with a crushing noise went right through the target, leaving a rugged, large, irregular hole, which, if made in a vessel at or near the water-line, would have caused a formidable leak. The shot penetrated not only the plate, but the strap of wrought-iron behind the bolts, 9in. wide. and three-quarters of an inch thick, and beyond this again bent one of the main ribs outwards. The fracture of the iron showed that the iron itself was of excellent quality, but there was evidently not the same compactness that is produced by hammered plates, and the rust was distinctly visible between the layers of the iron. Eight more bolts, too, went at this trial, breaking as short as the former had done, but only one of the rivet heads started. It was an extraordinary piece of ill-luck for this target to get three shots in succession in its weakest part, but so it did actually happen, and the last went through. The next trial was made with three 100-pounders, throwing solid cast-iron shot of 200lb., with 10lb. of powder. These all hit in the left-hand side of the target, buckling out the plate they struck till the ends projected nearly a foot, and destroying all, or nearly all, of the remaining bolt-heads in the other plates. This ended the first portion of the experiments, which, when against targets, are always made at Shoeburyness with shots of increasing weight fired singly, and then the same charges fired in salvoes together. But it was seen, after the last trial, that it was useless to proceed with the salvoes; for, as nearly all the bolt-heads retaining the plates had been broken off, it was evident that the first salvo would bring the whole mass to the ground. The firing was therefore discontinued, and the target thus practically struck its flag at the conclusion of the first half of the experiments. It was admitted on all hands that the target as constructed, had most undoubtedly failed.

Trial of Small-bore Rifles.—The result of the competitive trial of small-bore rifles held at the government ranges, Woolwich, from Feb. 26 to March 4, inclusive, has been published. Twenty shots in all were fired at each range of 500 and 1000 yards. At the first distance the mean radial deviation was, for Whitworth, ·53; Rigby, ·70; Henry ·82; Turner, ·97; and Terry, 1·90. At the second distance the mean radial deviation was, for Whitworth, 2·35; Turner, 2·52; Henry, 3·07; Rigby, 4·79; and Terry, 4·92. The competitors placed in order of merit, according to their mean figure, stand thus:—Whitworth, 2·88; Turner, 3·49; Henry, 3·89; Rigby, 5·49; and Terry, 6·82. Mr. Ingram retired from the contest.

Coles's Cupola.—The experimental firing from Capt. Cowper P. Coles's cupola was resumed at Portsmouth on the 1st ult., under the direction of Capt. R. S. Hewlett, C.B., commanding Her Majesty's ship *Excellent*, and was again attended with highly satisfactory results. Everything was carried on as in action, even to the hanging of the fighting lanterns, lit up, in their places inside the cupola. The target was placed at 3600 yards distance, and the practice made was exceedingly good, the second shot fired passing through it. The two 100-pounders were fired singly and together, and in quick firing six rounds were fired in as many minutes. The concussion from the discharge of the guns was but trifling, and was, in fact, found to be greater outside the shield than within it. The smoke cleared off as effectually as on the last day's experiments, and the guns, with their carriages, worked with the greatest facility. The shield ship which it is proposed to build on this plan will have no masts, and when afloat will show to the view above her deck merely her funnel and the tops of her shields. Cleared for action, the ship's bulwarks are thrown down all round her level with the upper deck, along the centre of which are ranged her cupola shields, resembling gigantic inverted tea-saucers, each containing two 100-pounder Armstrongs of 88 cwt. These shields rest upon towers, which are sunk through the upper deck, and are fixed on a turn-table on the deck below, which revolves, with the guns, shield, and men, as may be required. The height of the shield from the upper deck will be about 5ft., which will be but a small object for an enemy to fire at; shot can only strike it at an angle of 45 deg. The muzzle of the guns will be 9ft. 6in. from the water. The sides of the vessel will be covered with armour plating, the form and arrangement of which may most probably be a subject for future consideration, as the experiments that will shortly be commenced at Shoeburyness and others that will be carried out, both at Portsmouth and Shoeburyness, with cellular and other plates, will be certain to effect a great change in our present mode of attaching the armour plates to our iron ships. The shield ship will be 2500 tons measurement, and her estimated cost is, as far as can be ascertained at present, £180,000. Her draught of water is to be only 20ft., and her speed 12½ knots. Capt. Coles has arranged sets of tables applicable to the cupolas at each end of the ship for ascertaining the exact distance of an object. This is done, on the order "prove distance" being given, by taking the degrees of training given to the cupola in directing it upon the object, and referring to the table of angles. The distance is thus ascertained in the time merely required to train the cupola and without the use of any instrument, and if the object fired at be a moving one, the distance can be corrected and word passed along to the other cupola each time the guns are fired. It may be necessary to state here that the top of the shield itself is sighted like a rifle, independently of the guns it contains, and it is the cupola, therefore, which is directed upon the object, the guns revolving with the tower. The guns are placed parallel to each other, and the sights are immediately over them. The duty of directing the shield is given to one man, who is termed the "director," and who occupies an elevated position in rear of the two guns, from which he can look over the edge of the shield when bringing its guns to bear upon the object to be fired at. To protect his head while in this position, the front upper edge of the shield is fitted with two stout iron mantlets, with sufficient space for a line of sight between them.

TELEGRAPHIC ENGINEERING.

THE TELEGRAPH TO INDIA COMPANY lately received a message from Mr. Latimer Clark, at Suez, announcing the opening of a station at Jubal Island, in the Red Sea, so that messages can now be sent to that point to catch the mail steamers for India, China, and Australia, which, by the sanction of the Postmaster-General, are to call there instead of being sent by telegraph to Alexandria only. A saving of two or three days will be thus effected in communicating with the East.

THE BRITISH TELEGRAPH COMPANY have commenced erecting poles at Swansea, under their act of parliament, in order to connect that town with the rest of their system throughout the United Kingdom. This system now comprises upwards of 400 stations, and forms a distinct link between this country and the whole of the north and south of Europe.

BETWEEN LONDON AND CONSTANTINOPLE direct telegraphic communication now exists, signals having been sent and counter signals given, in a single minute, and messages interchanged with great facility and certainty.

GAS SUPPLY.

GAS HOLDER.—Messrs. Piggott, of Birmingham, are about to erect at the Liverpool Gas Works, a gas holder of the great diameter of 240 feet, with two "lifts" of 35 feet each, making a height of 70 feet. The capacity of the holder will be about 3,100,000 cubic feet. The Imperial Gas Company's holder, at their Hackney-road station, the largest yet erected in this country, is 201 feet in diameter and 80 feet high, while the same company have a holder also at Fulham, 200 feet in diameter, and nearly 70 feet high.

GAS DIVIDENDS.—The Crystal Palace District Gas Company have declared a dividend of 6 per cent. per annum on the preference, and 7 per cent. (exclusive of bonus of 1 per cent.) on the ordinary shares. The Willenhall Gas Company have declared the usual dividends, 10·7½ and 5 per cent., according to the class of shares. The Wolverhampton Gas Company, a dividend of 5 per cent. for the half year. The Cardiff Gaslight and Coke Company, a dividend of 10 per cent. on their old shares, and 8 per cent. on their new, and the South Shields Gas Company a dividend of 4½ per cent. on the half year.

GAS IN CORSICA.—The Corsican and Mediterranean Gas Company recently published their prospectus. They propose to supply Bastia and Ajaccio, the two chief towns of the island, with gas, and have obtained exclusive privileges from the municipal authorities for 50 years. At Bastia, which contains 20,000 inhabitants, the price stipulated to be paid for the street lamps is at the rate of 2·25 dollars for 1000 cubic feet consumed. The price of gas to be consumed in the public offices and municipal buildings is at the rate of 2·75 dollars, and that for the general public at 3·38 dollars per 1000 cubic feet. At Ajaccio, which is the capital of Corsica, and has about 16,000 inhabitants, the terms of concession are of the same character as at Bastia, while the prices are a trifle higher.

TELEGRAPHIC COMMUNICATIOM WITH IRELAND.—The Electric and International Telegraph Company's new submarine cable, for connecting England with the South of Ireland, has been successfully laid between the coasts of Pembroke and Wexford, in perfect working order. The cable, manufactured by Glass, Elliott, and Co., is 63 miles in length, contains four conducting wires, insulated with gutta percha and other materials on the latest improved methods, and is protected by 12 heavy iron standards, the total weight being 6½ tons per mile. The novelty introduced in the manufacture has been the coating of the entire cable with a composition (Bright and Clark's patent) for the purpose of protecting the iron from corrosion and decay, and the adoption of this principle is likely to have a most important influence on the further progress of submarine telegraphy as tending to insure the durability of cables for an indefinate period, and to render investments of capital in such undertakings of permanent value. The Electric Telegraph Company purpose using the same composition in the cable to be shortly laid between England and Holland. Mr. Canning, of the firm of Glass, Elliott, and Co., superintended the arrangements for paying out the Irish cable from the steamer *Berwick*.

WATER SUPPLY.

SOUTH ESSEX WATERWORKS COMPANY.—The prospectus of this new company has recently appeared. The proposed capital is £80,000, in 8000 shares of £10 each, and the projectors state that it is formed for the purpose of utilising a large supply of water at Grays, a locality in which very extensive springs have been opened during the progress of excavating chalk-pits. The quality of the water is represented to be exceedingly pure; and Brentwood, Romford, Ilford, and Barking are included among the places which the powers of the company will enable them to supply. Arrangements of a satisfactory nature have, it is stated, been made with the landowner for securing the benefit of the springs at a fixed royalty.

RAISING WATER.—An improved machine, based upon the properties of inertia of matter and centrifugal force, has been provisionally specified by Messrs. de Clerq and Chazelles, of Brussels. This invention consists in employing in a horizontal position a wheel, having its boss, or nave, traversed by, and fixed upon, a vertical hollow shaft, terminating at the bottom of a solid spindle maintained between cross bars or webs, to allow a passage and working in a suitable bearing. The lower part of the shaft and spindle is placed in the water to be raised. The rim or circumference of the wheel is composed of a number of cylinders closed at their ends, and placed near each other in the same direction as the arms. Above the boss, or nave, of the wheel there is a hollow truncated cone, traversed by the hollow shaft. In the interior of the cone there are partitions arranged so as to leave spaces between them. Each of the hollow cylinders carries two pipes extending upwards; one of these communicates with the truncated cone, and the other is placed vertically at the other end of the cylinder. The length of this pipe is varied to correspond with the length of the hollow shaft between the nave and the bottom spindle. Each of these vertical pipes has an elbow at the top, directed to the exterior part of the machine. The shaft is hollow from the bottom spindle to the top of the truncated cone. The other part of the shaft is to be solid, or if not there must be means provided to prevent any communication with the lower part. The interior of the hollow part of the shaft communicates with the interior of the cone by apertures near the top. At the top of the shaft there is a spindle working in a suitable bearing, and having a pulley or other contrivance for giving rapid motion to the shaft and parts which are connected with it. The machine has to be filled with water, and rapid motion given to it, and the water contained in the truncated cone and horizontal cylinders is powerfully forced towards the circumference, and rises in the vertical pipes, from when it is spirted out, but this water cannot flow to the circumference nor rise in the pipes without leaving a vacuum in the truncated cone and in the horizontal cylinders. The water from the supply reservoir is then drawn through the hollow shaft, and passing through the apertures near the top of the cone, fills the space from which the water has been forced. The water last supplied is in its turn forced outward, which causes another vacuum and aspiration, and so on. A continuous flow of water is thus obtained, the rapidity of which depends upon the speed given to the machine. The water which passes through the elbows of the vertical pipes is received in a reservoir, whence it can be led to any place required. Instead of having a communication by pipes between the truncated cone and the horizontal cylinders, longer cylinders may be used, and also several ranges of cylinders may be employed, one above the other, by which means the power of the machine is increased. The hollow shaft or suction-pipe may be materially shortened by causing its lower spindle to work in a socket placed at the bottom of a reservoir full of water, 8 or 9 yards above the supply reservoir. In the socket there are conduits, the bottom of which are in connection with a pipe, which descends to the supply water or other liquid. When the liquid is required to be raised very high several of these machines may be placed one above the other, and put in motion simultaneously from the same moving power.

THE BRIGHTON WELL now yields a good supply of water. At at depth of 1285ft. the green sand was reached, and a rush of water amounting to 650ft. with a continuious flow, took place. The diameter of the well, which has been dug throughout, is between three and four feet.

BOILER EXPLOSIONS.

ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.—At the ordinary monthly meeting of the executive committee of this Association, held at Manchester, on the 4th ult., 1862, J. M'Connell, Esq., in the chair, Mr. L. E. Fletcher, chief engineer, presented his monthly report, of which the following is an abstract:—"During the past month there have been examined 357 engines—1 specially; 490 boilers—5 specially, 9 internally, 63 thorougly, and 413 externally; in which the following defects have been found:—Fracture, 5 (2 dangerous); corrosion, 29 (4 dangerous); safety-valves out of order, 12; water guages ditto, 21 (5 dangerous); pressure guages ditto. 9; feed apparatus ditto, 7; blow-off cocks ditto, 27 (1 dangerous); fusible plugs ditto, 7; furnaces out of shape, 3 (2 dangerous); Total, 120 (14 dangerous.) Boilers without glass water guages, 8; without pressure guages, 4; without blow-off cocks, 9; without back pressure valves, 42. No less than five boilers have exploded during the last month; in one case, three working side by side being reported to have exploded simultaneously. This, as well as one of the other explosions, was attended with loss of life. Not one of the boilers in question was under the inspection of this Association. One of them, which had worked below ground, at the bottom of a colliery-shaft in the neighbourhood, I examined a few hours after the explosion had occurred, and found that the boiler, which had been made in 1860, was of plain cylindrical egg-ended construction, fired underneath, the diameter being six feet, the length twenty feet, the thickness of the plates ⅜ths of an inch, and the working pressure not exceeding 40lbs.; the boiler had given way at one of the transverse seams, and rent completely into two halves; these had not flown—as they usually do in such cases—in opposite directions with their butt ends foremost, like rockets, but one half had followed the other with the open ends facing one another. It was also remarkable that the leading half had become collapsed, and the mouth so compressed that there was barely room to crawl inside. This comportment of the parts, though peculiar, appeared to me on careful examination to be accounted for by the very confined and unyielding chamber in which the explosion had taken place, and indications of the course the parts had taken were recorded by scars upon the arched roof. The cause of the explosion was not at first sight very apparent; there was no reason to conclude that the pressure had been excessive, or that injury had been occasioned from shortness of water. A boiler of such dimensions, if well made and comparatively new, as this one was, would not burst even with a pressure of 100lbs. on the square inch, while a twin boiler working alongside at the time, and to which this was connected, was left uninjured, and has since been in use again. In addition to which, the line of fracture was not the one that would have been taken by over pressure, and I therefore searched for signs of constitutional weakness at the bottom of the transverse seam, where the rent had evidently commenced. On examining this, I discovered that the plate was internally grooved at the edge of the lap, just in the same way that the double-flued internally-fired boilers are so frequently found to be affected at their under side by the introduction of cold feed water. Within a few inches of this groove, just referred to, (the position of which was a short distance behind the fire bridge) the feed was introduced, the feed pipe being carried down almost immediately to the bottom plate, on which the cold water thus necessarily impinged, the force of its current being increased from the fact that it was laid on from the top of the shaft, the height of which was sufficient to give it a pressure considerably in excess of that of the steam, so that in a few minutes the bottom of the boiler could be deluged with a flood of cold water. Sudden alterations of temperature in a boiler are always injurious, and it appears to me that the constant repetition of these in the present instance resulted in fracture at the bottom of the transverse seam, which instantly extended all round the boiler, and thus caused the explosion. From the foregoing, I beg to recommend that all our members employing externally-fired boilers should introduce the feed as far from the furnace as possible, and should not allow the water to impinge directly upon the plates, but disperse it horizontally by means of an elbow delivering near the surface of the water. Under all circumstances, it is conducive to the longevity, as well as to the safety of boilers, to raise the temperature of the feed water before its admission as nearly to that of the steam as possible. Since writing the above, a case of partial injury has occurred to one of the boilers under the inspection of this Association, which is a further illustration of the mischief that arises from contraction of plates consequent on the sudden introduction of cold water. The boiler in question, which was of Cornish construction, and fired underneath, having been blown out at the end of the week, cold water was let into it, in order to save time in cooling, when a considerable leak was discovered at the bottom, and on examination one of the transverse seams was found to have cracked through the line of rivets for a considerable distance. In externally fired-boilers, if the water is blown out quickly after drawing the fires, it is quite possible for the plates at the bottom to be raised to a high temperature from the surrounding brickwork. It will be seen that internally-fired boilers are far less liable to this, since the temperature of brickwork beneath them is never raised to the same extent as it is in the first flue of the externally-fired boiler; in addition to which, should a seam rent occur at the bottom of a Cornish boiler, the strain upon it is reduced, not only on account of the diminished area of steam pressure acting upon the ends, but also by the additional power of resistance afforded by the metal of the flues themselves, so that, while a seam rent in the case of the Cornish boiler results only in a leak, in that of the cylindrical externally-fired boiler it may result, as in the instance given above, in fatal explosion. I think it well that these points of comparison should be clearly brought out, since the system of external-firing is not without its strong partisans, but it must be seen from the above that a boiler internally-flued, as well as internally-fired, loses nothing by the contrast either with a boiler of plain cylindrical construction, or with others externally-fired.

Fatal Boiler Explosion at Dudley.—An accident occurred on the 1st ult., at the Corbyn's Hall Iron Works, between Dudley Brierly Hill, causing the death of six people, besides maiming others. It appears that a steam hammer used at the works was worked by steam supplied from a boiler heated by flues connected with the adjacent puddling furnaces. This boiler was made on the premises eight years since, and was considered sound. It weighed about 13 tons, and was embedded in masonry. It burst with great violence, carrying off the roof of the building in which it stood. The boiler itself was driven through the roof and thrown on to an adjacent bank.

ACCIDENTS TO MINES, MACHINERY, &c.

Mine Accident.—On the 11th ult., three miners were working at the bottom of the 80 fathom level, in the Wheal Maria shaft of the Devon Great Consols, about four miles from Tavistock, and had blasted and loosened a portion of rock, and were clearing it away beneath them. They were at the time within six fathoms of the 95 fathom level, and were working towards it, when the rock under them by some means gave way, and two men fell with it a depth of about 33ft. From the injuries received one man died shortly afterwards; the other man being seriously injured.

Accident to a Lady from Machinery. — A serious accident lately occurred at Acklam, near Malton. A thrashing machine was at work, and Miss Charlotte Boulton, the daughter of Mr. F. H. Boulton, of Acklam Lodge, the occupier of the farm, was standing near, looking at the machine. It seems the wind carried her dress too near the tumbling shaft, which drew her in, and whirled her round and round repeatedly. When the machine was stopped, it was found that, in addition to other serious injuries, both the young lady's legs were broken. The accident resulted (as was the case at Burythorpe) from a neglect of covering the tumbling shaft. Miss Boulton is in a very critical state.

DOCKS, HARBOURS, CANALS, &c.

Deal Pier.—The Admiralty have given their consent to the construction of a pier at Deal, on iron piles, 920ft. out at sea, with a general width of 20ft., and at the head of 40ft.; height of platform above high water mark, 13ft., and an average depth at the head of the pier at low water spring tides of 10ft.

Hastings Pier and Harbour.—The works which are proposed to be constructed opposite to the present fish market and bleaching ground, are to consist of a pier composed of iron screw piles, with stone hearting up to high water mark; commencing from the site of the old fort, to the west, and extending about 1650ft in a southerly direction; then taking curve to the eastward, and running in an easterly direction for 1230ft.; and a small pier or breakwater, commencing about 1200ft. eastward of the other, from the "Rock a Nore," and being carried to the extent of 1650ft. in a line nearly parallel to the western pier. These works will enclose an harbour area at time of high water of 57 acres, and secure a depth of about 10ft. at time of low water spring tides, and from 20 to 30ft. in width.

Blackpool Pier.—The provisional directors of the Blackpool Pier Company have selected, from the fifteen designs submitted, that of Messrs. J. B. and E. Birch, London, deeming it most suitable to the Lancashire coast. The length of the pier will be 1350ft., with a rectangular end, containing 6000ft. The main body will be in spans of 60ft. The main girders are to be supported upon clusters of cast iron piles screwed into the clay, and of an average thickness of 1½in., by 12in. diameter.

The Mersey Docks and Harbour Bill.—It has been determined by the Mersey Docks and Harbour Board to withdraw for the present the bill which they had deposited before parliament for the purpose of obtaining powers to raise and expend £1,000,000 for the extension of graving dock and other accomodation at the north and south extremities of the port. This resolution has been adopted in deference to the representations of the steamship owners.

MINES METALLURGY. &c.

Gold Extraction.—An invention has been provisionally specified by Mr. B. G. Sloper, C.E., which is intended to effect the separation of particles of gold from earths and quartz, after being crushed or reduced to small particles, or pulverised by bringing mercury in contact therewith. His machinery consists of a hopper, opening at the bottom into a cylinder placed horizontally, or nearly so, and fitted with agitators secured to a vertical shaft made to revolve in the hopper. Inside the horizontal cylinder he places and causes to revolve an Archimedean screw, and crushed rock or auriterous earths are introduced, together with mercury, into the hopper. At the opposite end of the cylinder to that at which the charge is admitted there is an outlet into a vessel furnished with sieves of different degrees of fineness, and containing a set of channels or passages communicating at one end with a fan or blower, while they are open at the other to receive the mercury and gold in the state of amalgam, the air driven through them preventing the entrance of all matters of less specific gravity; the action of the vessel is assisted by a shaking or jogging motion being imparted to it. From the lower part of this vessel the amalgam falls into a cylinder, in which an agitator is caused to rotate, whereby the globules of amalgam are beaten into one mass, and until this mass is sufficiently rich in gold, it is pumped back to the hopper with fresh-crushed quartz or auriferous earth, to act and be acted upon as before.

Extracting Copper from its Ores.—Some improvements in the treatment of copper ores have been patented by Mr. Haeffely, of Kearsley, which consist firstly in the application of the refuse liquid discharged from chlorine generators as a menstruum for dissolving the copper contained in its ores, and, secondly, in precipitating copper from its solution by the action of the refuse known in alkali works by the name of vat waste.

Fusible Metals—In addition to the fusible metal (cadmium, 1 or 2 parts; tin, 2 parts; lead, 4 parts; bismuth, 7 or 8 parts), already described by Dr. B. Wood, of Indianapolis, U.S., and which melts at 150 deg. to 160 deg. Fah., he has since discovered another alloy (cadmium, 1 part; lead, 6 parts; bismuth, 7 parts), which melts at about 180 deg. Fah., or about midway between the melting points of the old fusible metal and that first described by Dr. Wood. The principal feature to be noticed in Dr. Wood's alloys is the proof given of the fluidifying properties of cadmium.

Plumbago, closely resembling the English, has been discovered in large quantities at Sonah, India. Its analysis gives:—In 1000 grains; water, 43·54; salts, soluble in water, 0·80; sulphates, 0·45; chlorides, 0·34; sesquioxide of iron, 32·94; carbonate of lime, 8·37; silica and alumina, 129·89; carbon, 784·52.

APPLIED CHEMISTRY.

Crystalline Structure of Wax.—Wax can be seen to assume a cystalline form in the following way:—A piece of bees'-wax is placed in an evaporating dish three-quarters filled with distilled water; the vessel is heated until the wax is perfectly fluid, and is then removed from the fire to cool slowly. Any bubbles of air in the wax must be got rid of by stirring with a hot iron spatula, so that it may have a perfectly clear surface. On watching the surface as it cools, solid points will be seen to form at the same moment at equal distances from each other, from which the crystallization starts, and soon spreads over the whole surface. The form of the crystals, say the authors, is the same as the honeycomb.

Metallic Copper as a Test for Sulphurous Acid.—Reinsch states that if a bubble or two of sulphurous acid gas be passed into half-an-ounce of strong hydrochloric acid, and then two drops of this acid mixed with 20 cubic centimètres of water and 10 cubic centimètres of strong and pure hydrochloric acid, a small piece of bright copper wire placed in the mixture and boiled, the wire is coloured distinctly brown, and in a short time has the same appearance as in the author's arsenic test. If a larger quantity of sulphurous acid is present, the wire becomes a deep brown black. Air containing SO_2 passed through a bulb containing hydrochloric acid and a piece of copper wire acts sensibly on the wire. This test, Reinsch says, will detect one-millionth part of sulphurous acid.

Prussic Acid.—M. Millon gives a method by which, he says, several quarts of anhydrous prussic acid can be obtained with as little trouble as absolute alcohol. He first submits the dilute acid to fractional distillation, collecting what comes over between 50° and 100° C. After two or three distillations he passes the vapour through two Woolf's bottles containing dry chloride of calcium, and condenses in a receiver placed in a freezing mixture—on this occasion stopping the distillation between 70° and 80°. The anhydrous acid M. Millon found to form a crystalline compound hydrochloric acid gas, and also with bichloride of tin, the latter compound being soluble in an excess of the prussic acid. The anhydrous acid forms other compounds, which are only stable as long as water is excluded. Moisture destroys them, and formiate of ammonia is produced. M. Millon observed that ammonia had a strong influence on the production of paracyanide compounds. A bubble or two of ammoniacal gas produced in two or three days the complete solidification of 200 grammes of the anhydrous acid. Dilution with five or six volumes of water only delayed the same result a few days. Ammonia is the sole cause of the production of these compounds. Acids or acidifiable matter preserves prussic acid either by neutralizing ammonia as soon as it is formed, or by preventing its formation.

APPLICATIONS FOR LETTERS PATENT.

Dated February 22, 1862.

473. A. Bornemann, 29, Monmouth-street, Bath—Improvements in the mode of construction fountains.
474. J. Millington, Oaken Gates, Salop—A new or improved hearse or bier.
475. G. T. Bousfield, Loughborough-park—Apparatus for elevating hay, straw, and earth.
476. C. H. J. W. Maximilian Liebmann, Huddersfield—Felted fabrics suitable for carpets and other similar purposes, and the apparatus employed therein.
477. J. Townend, Bradford—Jacquard engines.
478. J. P. D. Camp, The International Patent Agency, 100, Fleet-street—Arrangement of valves for steam and other engines, and with the means of operating the same.
479. D. B. White, Newcastle-upon-Tyne—Apparatuses for protecting liquids from the atmosphere while remaining in and during their discharge from the vessels containing the same.
480. G. Blackey, S. Blakey, and J. Blakey, Liverpool, and B. Whites, Birkenhead—Leggings or gaiters.
481. G. J. Oram, 19, Wilmington-square—Revolving pendant for giving greater security to watches and lockets against theft.
482. R. Foster, the younger, Beeston—Construction of buildings or erections to be used for horticultural or other purposes.
483. W. B. Johnson, Manchester—Steam engines.
484. M. A. F. Mennons, Rue de l'Echiquier, Paris—Burners for heating by gas.

Dated February 24, 1862.

485. W. Johnston, Glasgow—Gas and other lamps and stoves.
486. G. West, 1, Chapel-place, Long-lane, Borough—Construction of washing machines.
487. J. Cuningham and R. Cunningham, Paisly—Improved ornamental fabric, and improvements in weaving and in jacquard apparatus.
488. J. C. Haddan, Bessborough-gardens, Pimlico—Small arms and artillery, and projectiles for artillery.
489. R. Waller, Baker-street—Machinery and apparatus for joining leather and flexible and textile materials, and for the manufacture of boots and shoes and other coverings for the feet.
490. T. Blair, Carlisle—Machinery or apparatus for cutting, chopping, and breaking refined lump sugar and other substances.
491. W. Clark, 53, Chancery-lane—Apparatus for feeding or supplying steam boilers with water.
492. T. N. Kirkham, West Brompton, and V. F. Ensom, Highgate—Bleaching and dyeing yarn and thread when in the form of cops or otherwise wound.
493. P. G. B. Westmacott, Newcastle-upon-Tyne—Constructing and applying armour plating to ships, vessls, and forts.
494. T. Partridge, senior, 50, Tenby-street, Birmingham—Apparatus for printing railway and other tickets or cards.
495. L. Davis, Gloucester-gardens, Hyde-park, and F. M. Parkes, Marylebone-road—Production or manufacture of gas for lighting and heating.
496. R. A. Brooman, 166, Fleet-street—Reaping and mowing machines.
497. F. St. George Smith, Drogheda, Ireland—Machinery for grinding or reducing quartz, bones, grain, and other substances.
498. W. E. Newton, 66, Chancery-lane—Joints or chairs of the permanent way of railways.

Dated February 25, 1862.

499. J. Carnaby, 7a, Skinner-street—Turning, managing, and regulating the taps and valves of gas pipes.
500. J. Woodrow, Oldham—Manufacture of hats or covering for the head.
501. D. Wilkie, 15, Great Hermitage-street, Wapping, E.—A composition to be used on the bottoms of sailing vessels and steamers for the prevention of barnacles and other matters adhering thereto.
502. J. Piddington, 52, Gracechurch-street—Machine for shelling or husking all kinds of grain.
503. J. Piddington, 52, Gracechurch-street—Improved condensing apparatus.
504. E. Bliss, 36, Percival-street, Clerkenwell, and H. Lamplough, 113, Holborn Hill—Means for viewing microscopic photographs.
505. W. Clark, 53, Chancery-lane—Tobacco pipes.
506. T. Watson and R. Dracup, Thornton, near Bradford—Apparatus for preparing and combing wool and other fibres.
507. C. Minasi, 3, Saint James's-terrace, Kentish-town-road Cartridges.
508. C. W. Heckethorn, Saint Ann's Road, Brixton—Obtaining and applying motive power.
509. J. Imray, Westminster-bridge-road—Hinges.
510. J. Whitworth, Manchester—Manufacturing projectiles.
511. W. M. Cranston, 58, King William-street—Machinery for reaping and mowing.
512. C. Kingsford, Fenchurch-street—Manufacture of bread.
513. P. J. Guyet, Paris—Coupling for uniting pipes between locomotives and tenders.
514. H. W. Cook, Manchester—Apparatus for propelling by means of electricity.

Dated February 26, 1862.

515. J. Boocock and T. Davenport, Bury—Machinery for preparing and doubling cotton, and other fibrous materials.
516. A. Green, Rose Cottage, North-road, Forest-hill—Machinery for bordering paper envelopes and cards with black or colored borders.
517. A. Stephen, junior, Glasgow—Construction of ships or vessels.
518. G. Davies, 1, Serle-street, Lincoln's-inn—Emptying or draining the water from careening docks in maritime ports.
519. G. Rees, Goswell-road—Construction of marine subways.
520. A. D. Duparet, Paris—Ornamentation of tissues.
521. J. Dothee, Paris—Colouring or dying of horse-hair tresses, hats, or ornaments.
522. J. H. Bennett, Blackburn—Steam generators.
523. T. King and R. Varvill, Liverpool—Apparatus for controlling the flow of fluids for flushing water-closets.
524. J. Cliff, Imperial Potteries, Lambeth—Glazing stoneware, red clay ware, procelain, and other kinds of earthenware.
525. W. Miller, Upper Stamford-street, Blackfriars-road—Manufacture of sugar.
526. C. L. Knoll, 187, Tottenham-court-road—Pianofortes.
527. W. Clark, 53, Chancery-lane—Fastenings of bracelets and other articles of jewellery.
528. E. G. Bruzaud, Pembroke-road, Kensington—Pianofortes.
529. W. P. Savage, Roxham, Downham, Norfolk—Fire-arms.
530. J. Medhurst, 53, Lower Queen-street, Rotherhithe—Apparatus for reefing and furling the top sails of vessels.
531. J. Smith, senior, Coven, near Wolverhampton—Drying wheat and other grain.

Dated February 27, 1862.

532. G. Torr, Bucks-row, Whitechapel—Apparatus for manufacturing and reburning animal charcoal.
533. T. Adams, Deptford—Arrangements for effecting an equilibrium of the steam pressure upon valves.
534. C. Clark, 861, City-road—Tea and other trays for the table.
535. W. A. Gilbee, 4, South-street, Finsbury—Fire grates for steam and other boilers.
536. W. Smith, Salisbury-street, Adelphi—Method of making cigaretts, and in the apparatus, and materials to be employed therein.
537. J. Tangye, Birmingham—An improvement or improvements in hydraulic lifting jacks.
538. Sir C. T. Bright, Victoria-street—Electric telegraphs.
539. T. Bray, Dewsbury—Ornamenting wood in imitation of inlaid work.
540. R. Seager, Ipswich—Manufacture of boots and shoes.
541. J. R. Foster, Winsley-street, Oxford-street—Manufacture of bullion-fringe or cord.
542. W. S. Wood, Larchfield Foundry, Leeds—Valves for regulating the flow of steam.
543. J. Revell, Dukinfield—Oil cans.

Dated February 28, 1862.

544. P. D. Azemar, Paris—Mechanical arrangement for the winding up and the setting of the hands of watches by means of the knob of the pendant.
545. W. H. Muntz, Millbrook Lodge—Paddle wheels.
546. A. W. Makinson, Westminster, and W. F. Batho, Birmingham—Locomotive engines.
547. J. C. Ratliff, Coventry—Covers or bindings for books and blotting cases.
548. G. McKenzie, W. F. Murray, and J. Hamilton, Glasgow—Apparatus for the manufacture of bobbins or holders for textile materials.
549. J. Pollock, 27, Bridge-row—Apparatus for protecting trousers from mud.
550. J. L. Charcouchet, Lyons—Machinery for breaking stones.
551. R. A. Brooman, 166, Fleet-street—Manufacture of hats and bonnets.
552. J. Parker, 6, Lilford-road, Camberwell, Surrey—Applying steam as a motive power for propelling vessels.

Dated March 1, 1862.

553. T. Cowburn, Safety Valve Works, Little Peter-street, Manchester—Apparatus for raising and discharging boiling soap.
554. T. Bradford, Cathedral Steps, Manchester—Washing machines for cleansing domestic garments.
555. J. Sim, Aberdeen—Construction of gas meters.
556. H. C. Müller, Russell-place, New North-road—Imitation bear skin caps.
557. M. Dodds, Bedburn Iron Works, Hamsterley—Machinery for moulding articles of iron.
558. P. H. Boyer, Paris—Manufacture of boots and shoes.
559. P. J. Guyet, Paris—Taps or valves.
560. M. Gabriel and A. Gabriel, 33, Ludgate-hill—Bases of artificial teeth.
561. S. Hague, Westwinsted, Litchfield county, Connecticut, America—Apparatus for raising hammers.
562. A. E. Ragon, 4, Bernard-street, Russell-square—Electric alarums for telegraphic purposes.
563. A. Potts, Cappagh, Down, Ireland—Apparatus for scutching and refining flax, hemp, and other vegetable substances.
564. P. Robertson, Sun-court, Cornhill—Treating yeast.
565. S. G. Reynolds, Bristol, Rhode Island, America—Power Spading machines.
566. J. G. Jennings, Holland-street, Blackfriars—Chimneys or flues.
567. J. B. Kendall, Boston, Massachusetts, America—An improved horse shoe.
568. L. Martin, Tenison-street, York-road, Lambeth, and O. Penfold, Blackmoor-street, Drury-lane—An improved candle lamp.
569. C. Boolds, South-terrace, Kennington-park—Fastenings for gloves.
570. J. W. Davis and F. Davis, both of Hull—Apparatus for supplying feed water to steam boilers.
571. H. Bowen, Cardiff—Gas meters.

Dated March 3, 1862.

572. R. Shaw, jun., Portlaw, Waterford, Ireland—Facilitating the loading of guns.
573. P. Rémond, 39, Rue de l'Echiquier, Paris—Double rein bridle bits.
574. T. Bell, Wishaw, Lanark—Apparatus for distilling shale and other bituminous minerals.
575. A. Sheldon, Tipton, and J. Sheldon, West Bromwich—Improvements in smelting furnaces.
576. J. Schofield, Huddersfield—Looms for weaving.
577. A. Trevendale, Liverpool—Apparatus used in connection with cooking stoves.
578. T. Tillam, Church-street, Deptford Green—Purifying gas.
579. A. Bedborough, Southampton—Pillar letter boxes and letter bags.
580. J. B. A. Quiquandon, Paris—Jacquard machines.
581. G. Bischof, Swansea—Treating ores and solutions containing copper.
582. W. Conisbe, Herbert's-buildings, Waterloo-road, Southwark—Colour printing machines.
583. H. Bunning, Field House, New Cross, Deptford—Manufacture of lubricating grease or compounds.
584. F. B. Houghton, 6, Clarendon-terrace, Kensington—Manufacture of paper.

Dated March 4, 1862.

585. J. Gjers, Middlesborough, Yorkshire—Formation of moulds for casting iron.
586. J. Ellis, Petersham, Surrey—Fastening chains.
587. B. Standen, Salford, near Manchester—Manufacture of portable manure or fertilising compound.
588. P. Schafer and F. Schafer, Golden-square—Travelling bags.
589. J. T. Smith, Lee, Kent—Improved sight for fire-arms.
590. W. Tongue, Bradford, Yorkshire—Machinery for breaking and scutching flax, hemp, or other vegetable fibrous materials.
591. A. J. Sedley, 210, Regent-street—Metallic bedsteads.
592. G. H. Cottam and H. R. Cottam, St. Pancras Iron Works, Old St. Pancras-road—Horticultural buildings and other glazed structures.
593. T. Greenwood, Leeds—Sewing machines.
594. G. F. Guy, Bury St. Edmonds—Electro magnetic motive power engines.

Dated March 5, 1862.

595. J. Sidebottom, Harewood, near Mottram, Cheshire—Fire-arms and ordnance, and projectiles.
596. W. Tongue, Bradford, Yorkshire—Machinery for preparing silk, flax, hemp, or other fibrous materials.
597. J. Somervell and R. M. Somervell, Netherfield, Westmoreland, and M. Blanc, Birmingham—Manufacture of boots and shoes.
598. W. Hensman, Woburn, Bedfordshire, and W. Hensman, jun., Linsdale, Buckinghamshire—Apparatus for tilling land by steam power.
599. J. Chubb, St. Paul's Church-yard, and H. M. Burton, John's-place, Holland-street, Southwark—Apparatus for exhibiting jewellery in glass cases.
600. T. Bostock, Stone, Staffordshire—Manufacture of boots and shoes.
601. E. Partington, Heap Bridge, Lancashire—Cleansing rags or other materials used in the manufacture of paper.
602. F. N. Gisborne, 3, Adelaide-place, London-bridge—Indicating numerals or letters in railway tickets and other articles by peculiar devices cut therein.
603. W. E. Newton, 66, Chancery-lane—Apparatus for reducing wood, straw, and other vegetable substances to pulp for the manufacture of paper.

Dated March 6, 1862.

604. J. Barker, Todmorden, Yorkshire—Apparatus for casting drums, pullies, gear, and other wheels.
605. G. Lawrence, Newton-terrace, Westbourne Grove—Manufacture of flesh gloves, and flesh straps.
606. T. Hack, West Middlesex Water Works, Hammersmith, and A. E. Carter, West Middlesex Water Works, Kensington—Screw cocks.

Dated March 7, 1862.

607. J. G. Shipley, 181, Regent-street—Bridle-heads, reins, and bits.
608. M. B. Newton, 4, Inside Great Northern Goods Station, King's Cross, N.—Manufacture and construction of junction and other drain pipes in clay or other plastic materials.
609. T. Farrimond, Manchester—An improved safety cage for mines.
610. J. Revell, Dukinfield—Securing the rails of railways and tram ways to the chairs.
611. J. Carpendale and T. Middleton, Sheffield—Producing raised chasing on copper, silver, and Britannia metal.
612. J. Fowler, junior, D. Greig, and R. Noddings, of Leeds—Apparatus for cultivating or tilling land.
613. T. Ball, W. Ball, and J. Wilkins, Broadway, Nottingham—Manufacture of warp fabrics in warp machines.
614. R. Wright, 18, Albany-road, Camberwell—Heating and clarifying saccharine fluids.
615. I. Brook, 62, Basinghall-street—Ladies' dresses.
616. R. Restell, Croydon—Apparatus for connecting and disconnecting carriages and engines on railways.
617. T. H. Wood, Blackweir—Apparatus employed in the manufacture of artificial fuel.
618. H. B. Coathupe, Junior United Service Club, Saint James's—Manufacture of clips, hooks, and other such like fastenings.

Dated March 8, 1862.

619. A. W. Williamson, University College—Apparatus for generating steam.
620. H. Fletcher, 82, Wood-street, Cheapside—Clip for securing the steel of crinolines to the suspenders thereof.
621. G. Edmondson, Queenswood, Southampton—Washing machines.
622. A. Blair, Dawsholm Print Works, Dumbarton, North Britain—Rotatory engines.
623. W. Paterson, W. A. Sanderson, and R. Sanderson, jun., Gala Mills, Galashiels, Selkirk, North Britain—Finishing woven fabrics.
624. S. S. Bromhead, Bristol—Construction of boxes or receptacles for coals.
625. J. Platt and W. Richardson, Oldham—Apparatus for cleaning cotton from seeds, and for carding cotton.
626. J. Deane, junior, King William-street—Revolving fire-arms.
627. William N. Wilkins, Saint John's Wood—Manufacture of pigments for oil and water colors.
628. P. J. Guyet, Paris—Water meters.
629. S. Grice, Birmingham—Propelling ships and boats.
630. W. Clark, 53, Chancery-lane—Hats, caps, and other coverings for the head.
631. W. Palmer, Bell House, Soutweald—Manufacture of candles.
632. J. Fleming, Mincing-lane—Machinery for pressing cotton.
633. F. N. Gisborne, Adelaide-place, London-bridge, and Wickens, 4, Tokenhouse-yard, Bank—Means of indicating the presence of fire damp or choke damp in mines.
634. L. R. Sykes, New Coventry-street—Gloves.
635. F. R. Newton, and H. Codd, Esher-street, Westminster—Measuring the flow of liquids.
636. J. J. H. Gebhardt, Lawrence-lane—An improved fastening for albums and other books.

Dated March 10, 1862.

637. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Breech-loading fire-arms.
638. J. Duncan, Greenock—Manufacture of vinegar.
639. C. Massi, 13, Greville-street, Holborn—Means and apparatus for retarding and stopping carriages used on railways.
640. R. A. Brooman, 166, Fleet-street—Producing by the aid of photography copies of maps, charts, plans, and drawings.
641. W. Parker and G. H. Batman, Copmanthorpe—Steam engines.
642. W. Spence, 50, Chancery-lane—Projectiles.
643. W. J. Bennett, 21A, Millbank-street, Westminster—Preparation to be used with Portland and other cements.
644. A. C. MacLeod, Hanover-square—Ventilating hats.
645. W. S. Nosworthy, 79, Coleman-street—Upright and horizontal pianofortes.
646. A. Barclay, Kilmarnock—Traction engines.
647. J. B. G. M. F. Piret, 29, Boulevart St. Martin, Paris—lubricating apparatus.
648. J. T. Calew, Stavely, Derby—Safety apparatus applicable to cages or hoists used in mining or lifting machines.
649. M. Henry, 84, Fleet-street—Preparing hooks and hooks and eyes for sale or consumption.
650. H. H. Kromschroeder, 32, Princes-terrace, Regent's-park—Gas meters.

Dated March 11, 1862.

651. R. Peacock, Manchester—Manufacture of window blinds.
652. J. Nadal, 14, Brooke's Market, Brook-street, Holborn—A portable fountain for water and other liquids.
653. E. Parfitt, Drury-lane—A watch protector.
654. W. Barter, Brixham, Devonshire—Apparatus for propelling vessels.
655. E. Humphrys, Deptford—Steam engines.
656. O. Kerautret and J. Kerautret, Paris—Construction of buildings.
657. E. G. Camp, Bristol—Brushes.
658. C. Hall, Navestock, Essex—Implements for breaking up the soil.
659. T. B. Wilson, Queen's Ferry, Flintshire, and W. Wilson, Preston, Lancashire—Apparatus for the splitting of cane and other fibrous substances.
660. H. Baynes, Clement's-lane—Bankers' cheque books.
661. R. Smith, Glasgow—Telegraph posts.
662. G. Davies, 1, Serle-street, Lincoln's-inn—Attaching artificial teeth to plates and to each other.
663. W. Clark, 53, Chancery-lane—Apparatus for effecting submarine operations.

Dated March 12, 1862.

664. A. R. L. M. de Normandy, Odin Lodge, King's-road Clapham Park—Connecting gas and other pipes.

665. A. J. Russell, Edinburgh—Arrangement of the electric conductors for submarine telegraphs.
666. J. Fawcett, New Swindon, Wiltshire—Manufacture of cranks and crank axles for locomotive and other engines.
667. W. H. Latham and F. C. W. Latham, Bolton, Lancashire—Apparatus for perforating and numbering tickets.
668. W. H. Latham and F. C. W. Latham, Bolton, Lancashire—Apparatus for cutting paper, pasteboard, and other similar substances.
669. A. Watson, Glasgow—Hot pressing apparatus.
670. J. Johnson, Heaton Norris, Lancashire, and S. Morris, Stockport, Cheshire—Steam boilers.
671. W. Conyers, Leeds Bridge, Leeds—Currying leather.
672. E. Molyneux, jun., Seavien, Enniskerry, Wicklow, Ireland—Utilizing the waste heat of the products of combustion as they escape from a furnace.
673. P. Gondolo, Paris—A new or improved baking oven.
674. A. M. A'Beckett, Surbiton, Surrey—Railway signal apparatus.
675. W. Clark, 53, Chancery-lane—Manufacture of coloured inks.
676. F. Tolhausen, Paris—A new toy which he denominates "the colorimixt top."
677. J. E. Grisdale, 73, Oxford-street — Photographic cameras, and the mode of fixing the lens therein.
678. E. G. Fitton, Ardwick, Lancashire—Machinery for winding yarn or thread on to bobbins or spools.
679. W. E. Newton, 66, Chancery-lane—Manufacture of cartridges.

Dated March 13, 1862.

680. J. S. Hendy, Essex-street, Strand—Construction of chimneys and chimney pots.
681. F. H. Fontaine, Paris—Reproducing all sorts of photograhies, drawings, paintings, and engravings.
682. L. Vidie, Paris—Construction of aneroid barometers.
683. J. Cunningham and R. Cunningham, Paisley, Renfrew—Jacquard apparatus.
684. J. Hunter, Dalmellington Iron Works, Ayrshire, North Britain—Apparatus for removing slag from furnaces.
685. G. Ermen, Manchester—Case for the protection of threads of cotton or silk when in a spooled or otherwise wound state.
686. H. Fletcher, Market-street, Manchester—Cleaning and preparing cotton.
687. J. Wadsworth, Salford, near Manchester—Manufacture of boots and shoes.
688. J. Howard and J. Bullough, Accrington, Lancashire—Warping and beaming machines.
689. E. T. Hughes, 123, Chancery-lane—Furnaces for consuming smoke.
690. S. V. Bonneterre, C. T. Erhart, and J. F. Monti, Paris—Apparatus for regulating the pressure of steam in steam boilers and the combustion in their furnaces.
691. M. Henry, 84, Fleet-street—Stuffing boxes.
692. R. A. Brooman, 166, Fleet-street—Apparatus for measuring and regulating the flow and pressure of gas.
693. G. Calvert, Islington—Castors.
694. S. K. Thompson, Coniston, A. T. Thompson, and S. Mawson, Bolton-le-Moors, Lancashire—Railway apparatus for communicating between guard and driver.
695. J. B. Howell, Sheffield—Manufacture of chains and chain cables.
696. H. Fletcher, 82, Wood-street, Cheapside—Neckties, scarfs, cravats, and collars.
697. W. E. Newton, 66, Chancery-lane—Armour plates for vessels of war.
698. E. Bolton, Warrington, Lancashire—Apparatus for transferring liquid matters from one vessel to another.
699. R. Schomburg, 90, Cannon-street, and A. Baldamus, Charlottenburg, Berlin—Purifying illuminating gas.
700. J. Kent, Moscow, Russia—Cleansing and bleaching.

Dated March 14, 1862.

701. A. Quinard, Paris—Horse shoe nails.
702. R. Garthwarte, Darlington—Providing extra, superior, or better accommodation in double tenement houses.
703. G. H. Birkbeck, 34, Southampton Buildings—Trusses or bandages, and pessaries so be used therewith when required.
704. G. Bennett, 21, Manchester Buildings, Westminster—Coating and covering of wrought iron for the purpose of preserving it and prventing oxidation.
705. G. H. Sanborn, Boston, U.S.—Gas regulator.
706. L. Gabler, 41, Bernard-street, and M. Zingler, 14, Granville-street—Manufacturing articles from ivory and bone.
707. G. T. Bousfield, Loughborough-Park, Surrey—Machinery for digging and disintegrating the earth for agricultural purposes.
708. A. J. Paterson, Edinburgh—Electric telegraph cables.
709. M. A. Muir, and J. McIlwham, Glasgow—Railway sleepers and chairs and in the mode of fixing rails.
710. W. Turner, Nottingham—Construction of bakers' ovens, and the use of furnaces and other apparatus connected therewith, and the means or appliances employed therein.

Dated March 15, 1862.

711. A. and W. Coles, Wych-street, Strand—Constructing of trusses for cases of hernia.
712. W. Clark, 53, Chancery-lane—Brake for railroad carriages.
713. H. Emanuel, Brook-street, Hanover-square—Manufacture of ornaments for personal wear.
714. C. N. Kottula, Belleisle, Middlesex—Manufacture of combined soaps.
715 G. B. Pettit, New Oxford-street, Middlesex—Method of, and apparatus for heating water and other liquids, applicable also to the evaporation of liquids.
716. J. Smadja, 16, Stamford-street—Bustles and crinolines, and materials used in their construction.
717. W. McAdam, Glasgow—Manufacture of blocks, pulleys, and weights for window sashes and other purposes, and mode of applying the same.
718 J. Hunter, and R. Scott, Coltness Iron Works, Cambusnethan—Reaping machines.
719. J. Grant, Maidstone—Construction of portable railways, and the trucks or carriages to be used thereon.
720. H. Y. D. Scott, Brompton Barracks, Chatham—Manufacture of cement.
721. S. N de Barbezières, Baris—Horse shoes.
722. J. Avery, 26, Mark-lane—Purifying coal.
723. G Hamilton, 6, Willow-terrace, Islington—Tumbler locks.
724. J. Robey, 49, Hereford-road, North—Manufacturing and refining sugar, and in apparatus employed therein.
725. W. Pickstone, Radcliffe—Piled fabrics.
726. J. T. and T. Pendlebury, Bury—Form of lubricator.

Dated March 17, 1862.

727. W. Clark, 53, Chancery-lane—Water meters.
728 A. S. and A. R. Stocker, Wolverhampton—Manufacture and construction of articles to be worn by bipeds and quadrupeds.
729. W. E. Gedge, 11, Wellington-street, Strand—Crinolines.
730. W. B. Lord, Plymouth, F. H. Gilbart, Brixton—Raising, lowering, and releasing ships' boats or other heavy bodies.
731. I. P. Mongruel, Paris—Cold vapour generator, which may also be used in the carburatian of illuminating gas.
732. W. Bowser, Glasgow—Ships' fire hearths or boiling and cooking apparatus.
733. G. Davies, Serle-street, Lincoln's-Inn—Apparatus for drawing.
734. J. & W. Weems, Johnstone. Renfrew, N.B.—Apparatus for indicating the pressure or quantity, and regulating the discharge of fluids.
735. B. Todd, Falmouth—Manufacture of antimony and the oxide of antimony.
736. W. Barford, Peterborough—Rollers for rolling land.
707. W. Barber, Stockport, Chester—Hats.
738. G. T. Bousfield, Louborough-park, Brixton—Cranks for driving sewing machines and other machinery.
739. J. M. Courtauld, Braintree, Essex—Power looms.
740. J. Hicks, Hatton-garden—Mercurial barometers.
741. E. Smith, Carlisle-street, Soho—Watch keys.
742. W. Gossage, Widnes—Soda and potash.
743. T. Waller, Conduit-street, West—Breech loading firearms.
744. T. Myers, Brighton—Meters for measuring water, gas, or other fluids.

Dated March 18, 1862.

745. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Arresting headstrong or runaway horses.
746 M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Cooling and filtering apparatus.
747. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—Manufacture of paper pulps of a vegetable product.
748. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—An improved needle-threading apparatus.
749. J. Banks, 19, Salisbury-street, Adelphi — Electromagnetic telegraph printing apparatus or marking instruments.
750. H. Bailly, 5, Salter's Hall-court, Cannon-street—Manufacture of paper.
751. T. Dunn, Windsor Bridge Iron Works, Pendleton Manchester—Construction of houses.
752. W. Tongue, Bradford—Machinery for preparing, hackling, dressing, and combing flax.
753. C. Iles, Birmingham—Manufacture of umbrellas and parasols.
754 A. A. Beaumont and J. A. Escalier, 2, Rue Ste. Appoline, Paris—A flying top.
755. J. A. Jaques and J. A. Fanshawe, Tottenham, and F. Jaques, Draylesdon—Construction of elastic surface rollers.
756. J. A. Ronketti, 31, Northampton-road, Clerkenwell—Meteorological instruments and Thermometers.
757. J. Wright, 42, Bridge-street, Blackfriars, and H. Wheatcroft, 27, Fore-street—Machinery for lasting and making boots and shoes.
758. S. Slack, West-street, New Sneinton—Manufacture of stockings.
759. F. Warner, 8, Crescent, Cripplegate—Cocks or taps.
760. R. A. Brooman, 166, Fleet-street—Manufacture of barytes and barytic products.
761. J. T. Buck, New North-road—Instruments and work cases known as ladies' companions.

Dated March 19, 1862.

762. A. Krupp, Essen, Rhenish Prussia—Manufacturing shafts for steamboats and other purposes.
763. R. Hadfield and J. Shipman, Attercliffe, Sheffield—Hardening and tempering wire and crinoline steel.
764. S. Desborough, Noble-street, St. Martin's le Grand—Sewing needles.
765. R. Wilson, Patricroft, near Manchester—Hydraulic presses.
766. S. Moore, Liverpool—Machinery for compressing and cutting tobacco.
767. R. A. Brooman, 166, Fleet-street—Printing and painting upon glass and ceramic wares and upon metallic and mineral substances.
768. R. A. Brooman, 166, Fleet-street—Reproducing, or prodncing copies of guipure lace, embroidery, and other like articles.
769. R. A. Brooman, 166, Fleet-street—Rotary engines.
770. R. A. Brooman, 166, Fleet-street—Apparatuses for drawing in and paying out chain cables.
771. J. Cumming, Edinburgh—Apparatus for distributing and setting up type.
772. C. M. Todd, 84, Hackney-road—Sewing machines.

Dated March 20, 1862.

773. B. Samuelson, Banbury—Chain harrows.
774. J. G. T. Campbell, 1, Hatcham-terrace, Old Kent-road—Ships' propellers.
775. A. Hill, Cheddar, Somersetshire—An improved fastening for stays.
776. R. M. Roberts, Kensington—Obtaining and applying motive power.
777. E. Smith, Sheffield—Apparatus for cutting stone, wood, and other material.
778. E. Field, Buckingham-street, Adelphi—Regulating the flow of gaseous and other fluids.
779. W. Baddley, Angel-terrace, Islington—Preparing tobacco for smoking.
780. W. Clark, 53, Chancery-lane—Manufacture of soap.
781. J. G. Thompson, Madras, East Indies—Pianofortes, organs, harmoniums, and other instruments having key boards.

Dated March 21, 1862.

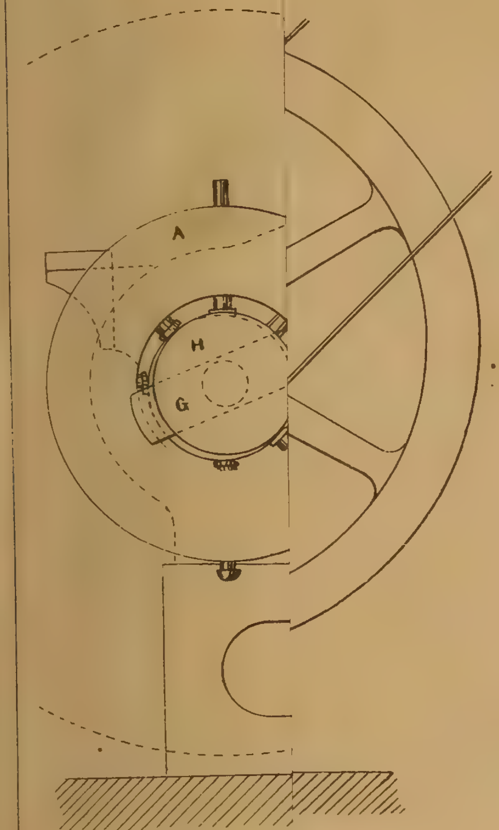
782. D. E. Siebe, Mason-street, Lambeth—Machinery for refrigerating or producing cold.
783. R. Kay, Castleton Print Works, Lancashire—Printing calico and other surfaces, and apparatus connected therewith.
784. W. J. Curtis, 13, Tuffnall Park-road, Holloway—Apparatus to ascertain and point out the fares and earnings or receipts of public vehicles and their conductors.
785. J. Newall, Bury, Lancashire—Supplying gas to railway carriages, stations, steamboats, and other vessels, omnibuses, or other carriages, at any required pressure.
786. J. M. Hart, 76, Cheapside, and R. Lavender, 332, Goswell-road—Means for generating steam.
787. J. Fawcett, Wakefield, Yorkshire—Manufacture of soap, particularly applicable to the scouring, cleansing, and fulling of woollen or other cloths.
788. J. Humphrys, Tower Hill—Steam engines.
789. B. H. Mathew, St. James'—Fire-arms and cartridges.
790. W. Phelps and W. R. Lambery, Nottingham—Woven fabric, and machinery for manufacturing the same.
791. J. Warbrick, W. Warbrick, and A. Travis, Chester—Engines for carding cotton and other fibrous materials.
792. W. Clark, 53, Chancery-lane—Sewing machines.

Dated March 22, 1862.

793. D. Abercrombie, Glasgow—Power looms.
794. T. Marsh, West Bromwich, Staffordshire—Hames for horses and other draught animals.
795. T. Fontenay, Grenoble, France—Smoke consuming furnaces.
796. E. Owen, Bala, Merionethshire—Hydraulic engines known as turbines.
797. E. Lord, Todmorden, Yorkshire—Machines for preparing cotton and other substances.
798. J. Davis, Kennington—Wind musical instruments.
799. R. Gladstone, Broad Green, Lancashire—Tilting or tipping waggons.
800. F. W. Collis, Deptford, and P. Haden, Hackney—Consuming smoke, and apparatus connected therewith.
801. J. H. Tuck, 35, Cannon-street—Manufacture of flexible valves.
802. J. G. Jennings, Holland-street, Blackfriars-road—Manufacture of biscuits.
803. T. M. Smith, High-street, Kensington—Candles.
804. T. F. Hale, Bristol—Valves.
805. W. Holiday, Bradford, Yorkshire—Press plates.
806. G. Hartshorne, jun., and D. G. Ward, Dudley, Worcestershire, and W. Woolley, Tipton, Staffordshire—Punching or perforating metal plates or sheets, and apparatus or machinery to be employed for that purpose.
807. M. Henry, 84, Fleet-street—Kilns, ovens, and furnaces.

Dated March 24, 1862.

808. J. H. Brierley, Halifax, Yorkshire—Clasp or fastener for reversible belts, bands, or straps.
809. J. Clark, Shiffnal, Shropshire—Carriage axles.
810. T. White, Birmingham—Ornamentation of nut crackers and lobster crackers.
811. S. E. Turner, Birkenhead—Apparatus for burning a mixture of inflammable gas and air.
812. C. M. Moullier, Paris—Flat cables or chains.
813. B. Fleet, East-street, Walworth—Apparatus for manufacturing and bottling soda water.
814. J. Topham, Nottingham—Apparatus used for cleansing out the scum and removing the sediment from the water in steam boilers, and preventing incrustation therein.
815. E. Morewood, Stratford, and A. Whytock, St. Martin's-lane—Process of coating metals, and apparatus employed therein.
816. W. Henson, Nottingham—Knitting machinery.
817. J. Stewart, Glasgow—Manufacture of cards for Jacquard weaving.
818. M. A. F. Mennons, Paris—Machinery for the production of ornamental stitching or embroidery.



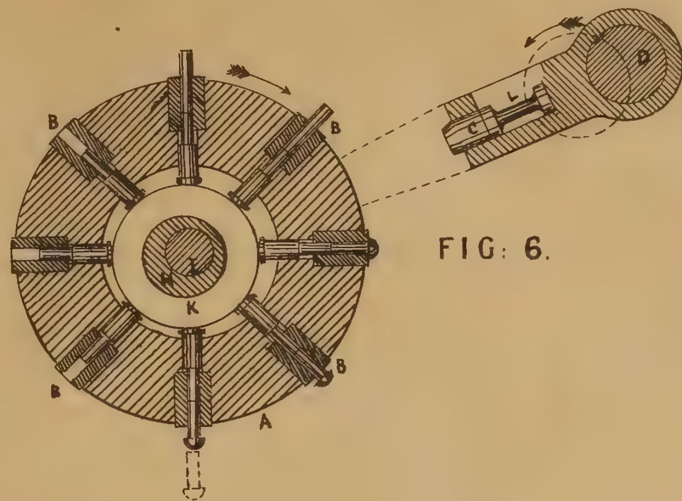


FIG: 6.

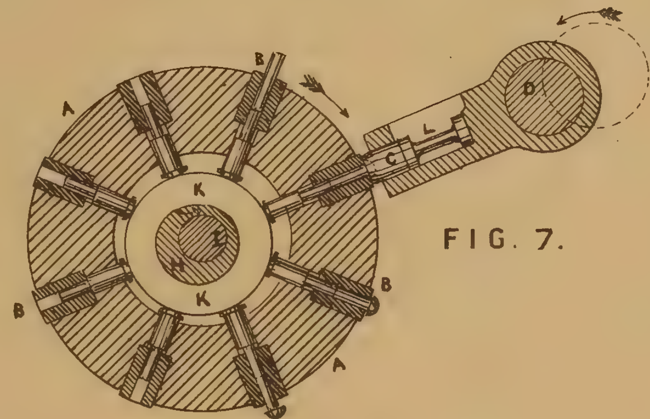


FIG. 7.

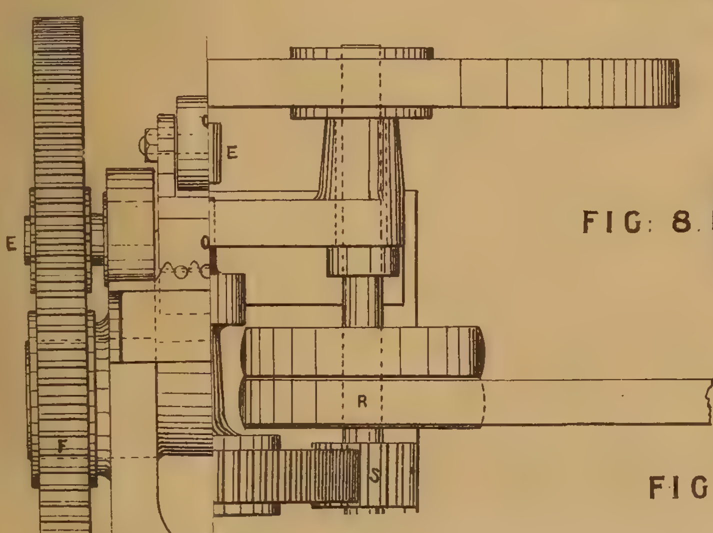


FIG: 8.

FIG. 9.

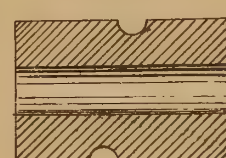
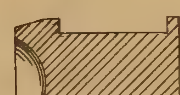


FIG: 10

FIG: 11.



RIVET-MAKING MACHINERY.

FIG: 1.

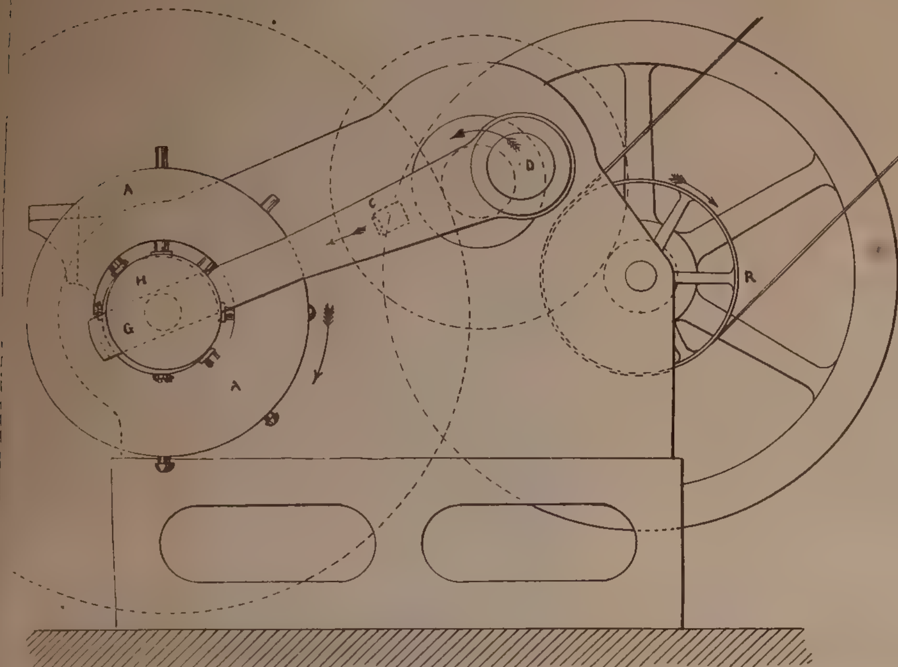


FIG: 2.

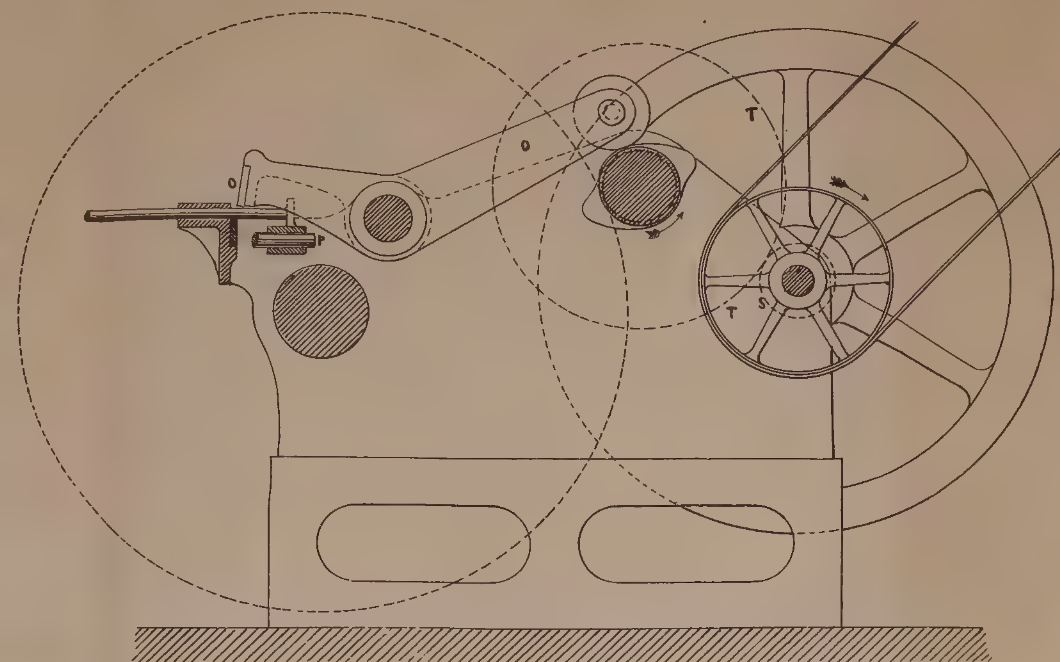


FIG: 6.

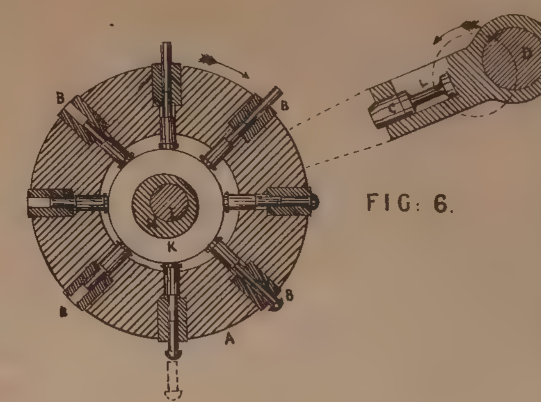


FIG. 7.

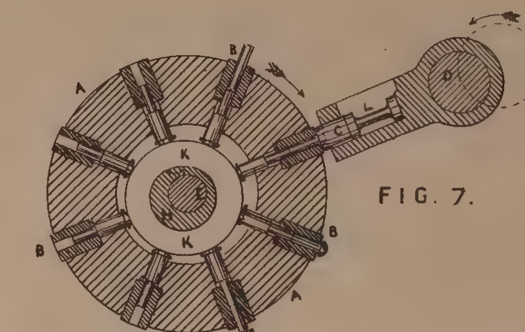


FIG: 4.

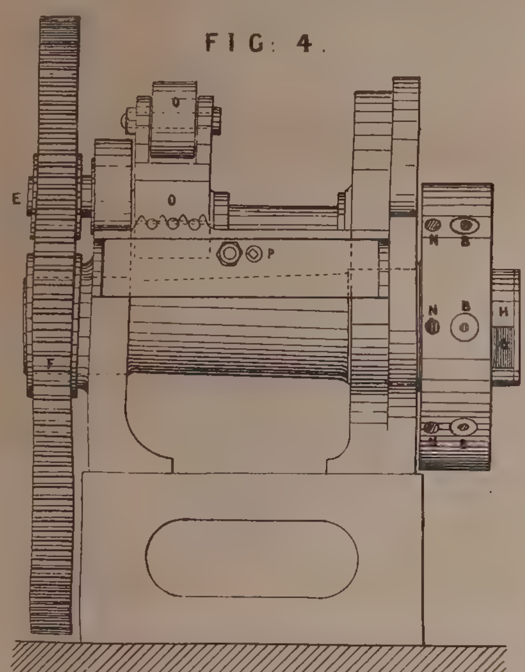


FIG: 5.

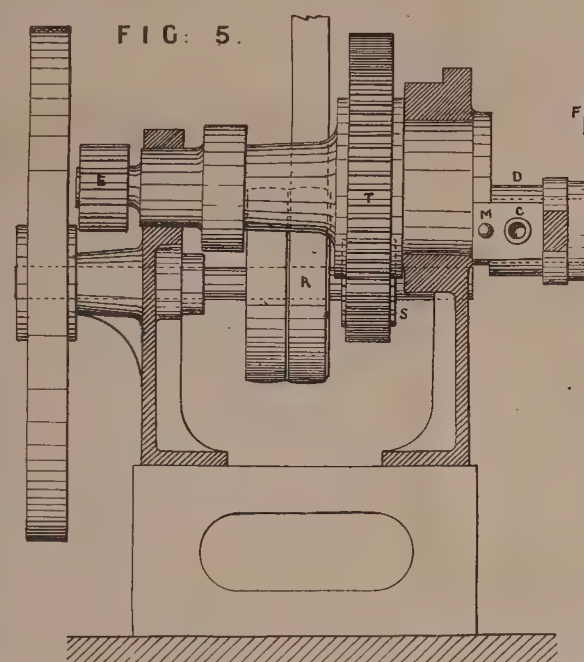


FIG: 3.

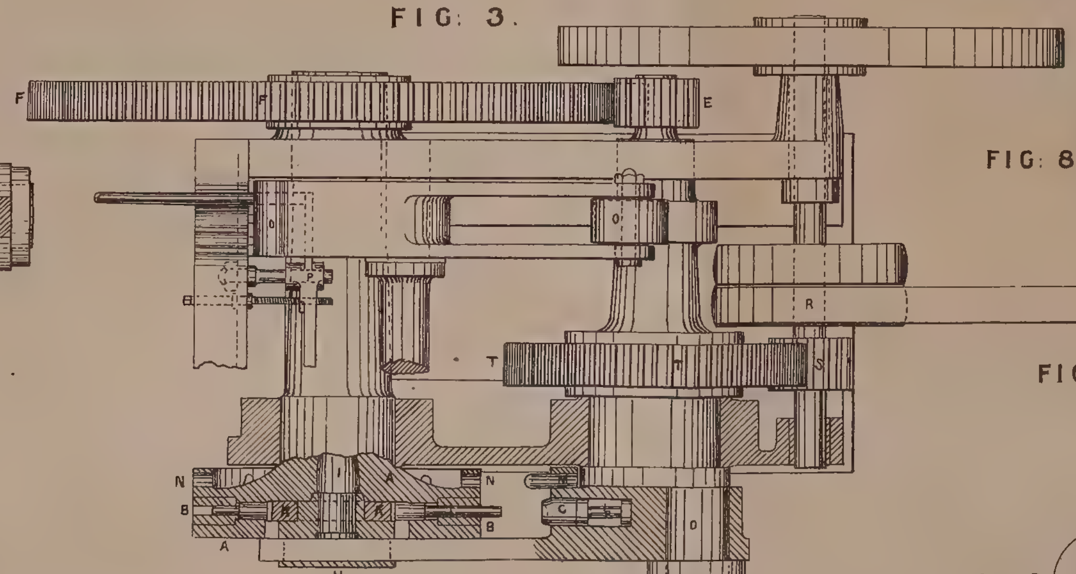


FIG: 8.

FIG. 9.

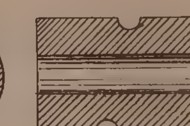


FIG: 10

FIG: 11.

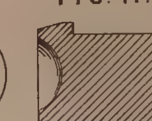


FIG: 12

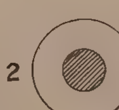
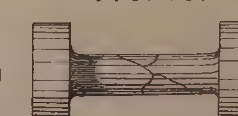


FIG: 13.



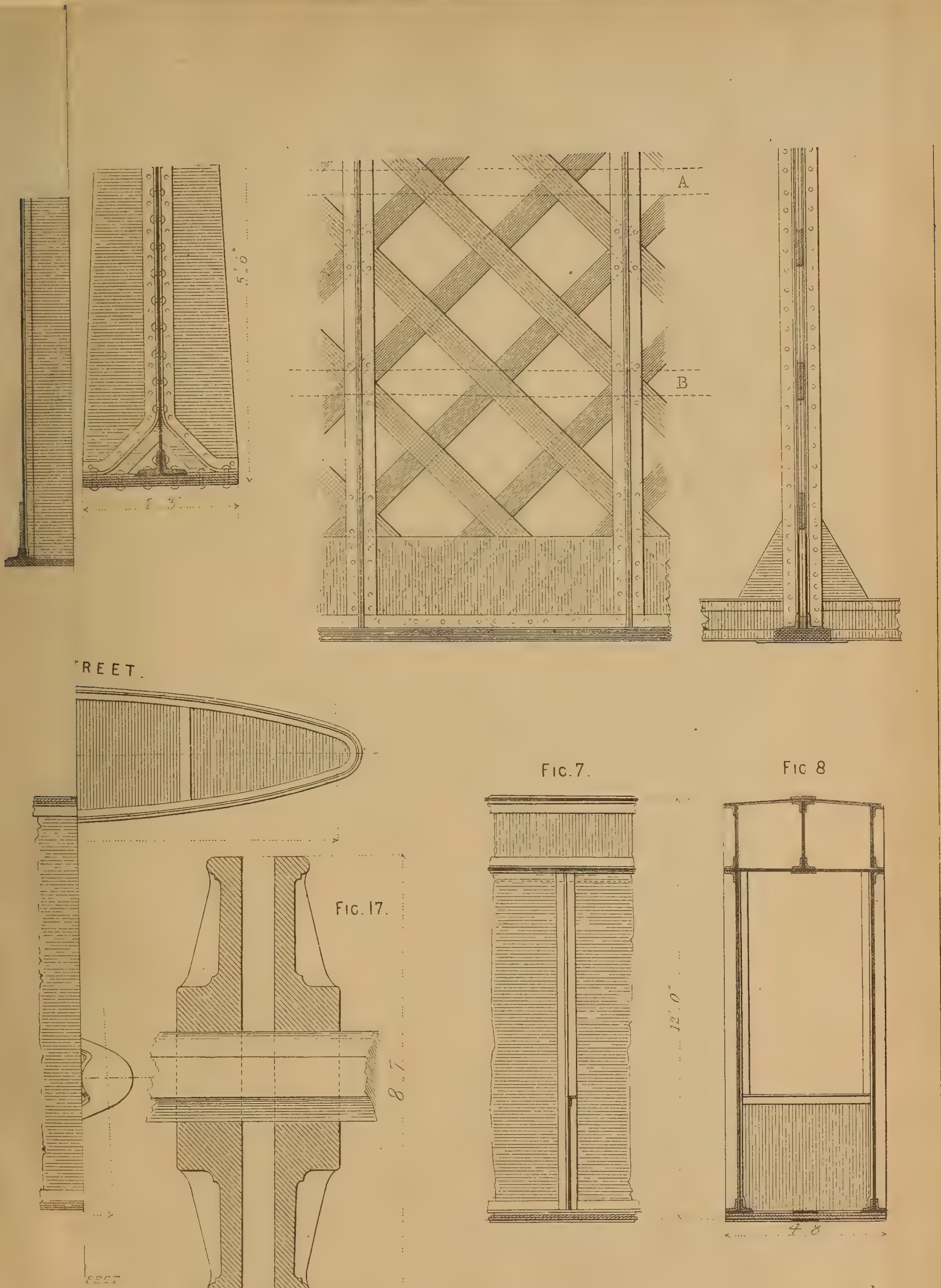
Scale to FIGS 1.2.3.4.5.6 & 7.

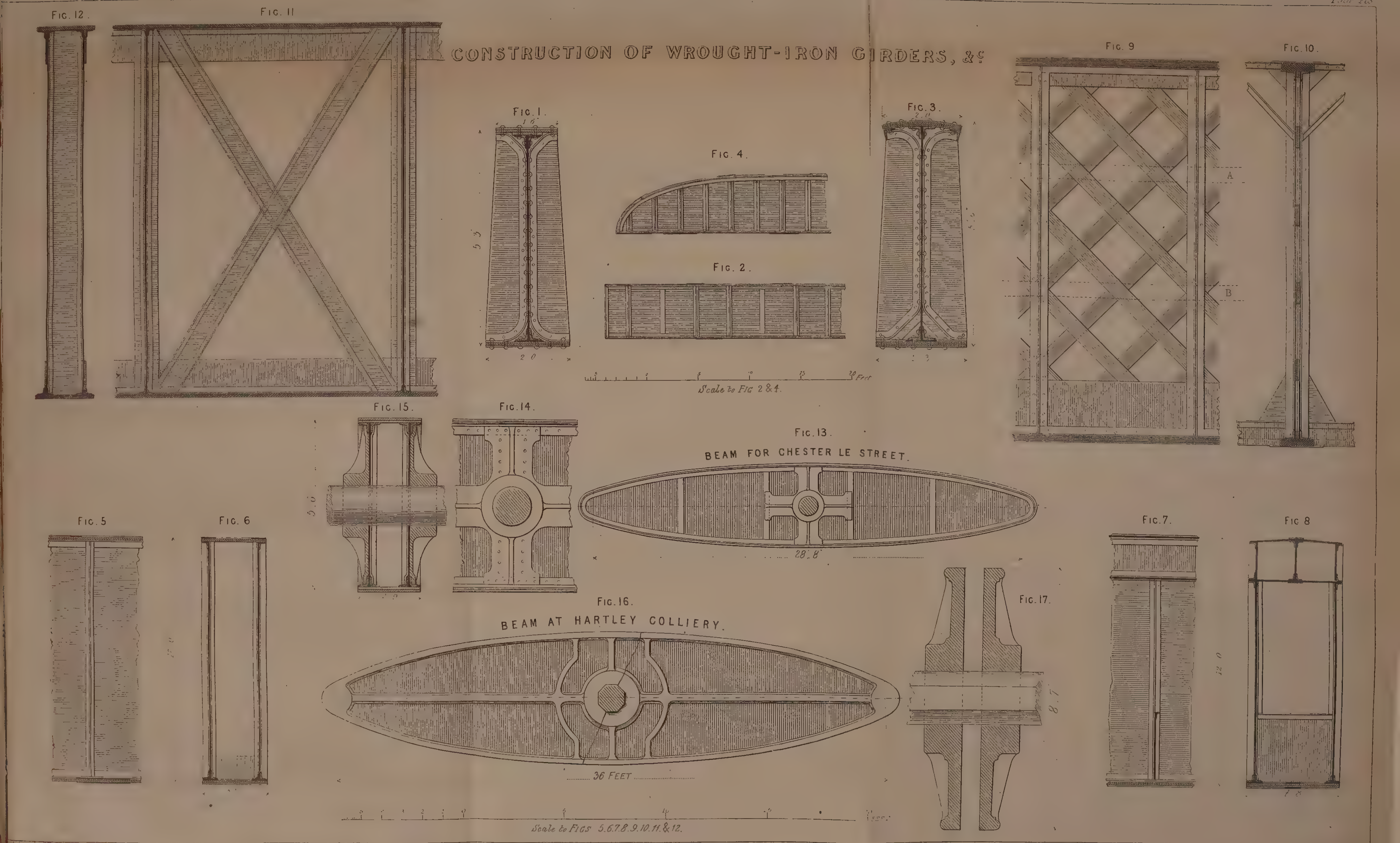
10 5 0 10 20 30 40 50 60 70 80 Inches.

Scale to FIGS 8.9.10.11.12. & 13.

0 5 10 Inches

W. Smith, C.E. direx.


A
B
5' 6"
2' 3"
TREET.
FIG. 17.
8' 7
FIG. 7.
12' 0"
FIG 8
4' 8


CONSTRUCTION OF WROUGHT-IRON GIRDERS, &c.
Fig. 12.
Fig. 11
Fig. 1.
1 6
5 9
2 0
Fig. 4.
Fig. 2.
Scale to Fig 2 & 4.
Feet
Fig. 3.
2 0
2 3
Fig. 9
A
B
Fig. 10.
Fig. 15.
Fig. 14.
Fig. 13.
BEAM FOR CHESTER LE STREET.
28 8
Fig. 5
Fig. 6
Fig. 7.
Fig 8
12 0
Fig. 16.
BEAM AT HARTLEY COLLIERY.
36 FEET
Fig. 17.
8 7
Scale to Figs 5.6.7.8.9.10.11.&12.

THE ARTIZAN.

No. 233.—Vol. 20.—MAY 1, 1862.

PEAT-CHARCOAL OR COKE, AS A METALLURGICAL FUEL.

In many parts of England, Ireland, and Scotland, large tracts of land are found in which the surface, to a very considerable depth, consists of peat. This sterile matter in its semi-solid state is wholly unfitted for the uses of the agriculturist. It covers tracts of such vast aggregate extent as to form a notable—in Scotland and Ireland a very seriously notable—proportion of the whole country. It reaches often to a depth of 40ft., and altogether constitutes a mass, the cubical bulk of which is enormously great.

Peat has been made for years past the subject of long-continued experiment in many different ways. Experimentalists and capitalists have been alive to the importance of being able to turn to commercial account these vast masses of crude material, not only useless in a great measure itself, but covering and encumbering land which would be useful in agriculture were it not for its presence. In many European countries, particularly Prussia and Holland, peat forms the staple fuel of the country; and in this country, also, peat possesses a certain value as a substitute for coal in a very limited degree. Here, however, where the supply of superior fuel is unrestricted, peat, as a fuel, is not likely to come into general use; in this respect comparison with coal is too much to the disadvantage of the peat; but when we consider the question of employing peat, or rather its coke, as a metallurgical fuel, the case is very much altered.

If we reflect for a moment upon the origin of peat, and the nature of the changes by which it is produced, we shall perceive at once that it contains the elements of a very valuable fuel, and when, in addition, we refer to the actual composition of peat and the earthy matters which are always in greater or less quantity found in it, we shall be convinced that, as respects its composition, peat-coke is equal to wood-charcoal, whilst physically it has the advantage of greater compactness and durability under the action of a furnace.

Peat, as is well known, owes its origin to the decomposition of vegetable organic matter, but, unlike the formation of coal, which has been effected by an action occurring long before our period, that of peat appears to be still progressing. When the decomposition of the vegetable matter is very far advanced, the traces of organic origin in the peat become more and more indistinct, and in some bogs the whole mass has been converted into that dark-coloured unctuous substance called ulmine or ulmic acid.

Peat consists, then, of vegetable fibre, which has been brought by a natural change into a carbonaceous form somewhat resembling coal.

Peat, wood, and coal, when subjected to a certain high temperature—that is, to a red heat—have their peculiar characters strongly modified.

The elements of which they are composed, take among themselves new arrangements; a portion of the original substance is separated in the volatile form, and passes away as gas and condensible vapour, and the matter which is left, is a carbonaceous substance—charcoal or coke. Three classes of product are the consequence of the application of heat to the substance mentioned. These products are gas, volatile liquids, tarry and aqueous, and the carbonaceous residue. It is only with the gas and coke, or charcoal, obtained from peat, that we concern ourselves, at present. If we heat the peat in a close vessel, such as a gas retort, heating the retort to, say bright or cherry red heat, we can obtain from good dried peat 11,000 or 12,000 cubic feet of gas per ton of peat, and a quantity of charcoal, equal to about twenty-five per cent of the peat employed. The gas is a mixture of light carburetted hydrogen, a little olefiant gas, carbonic acid, and carbonic oxide gases; the composition of this gas shows that it is destitute of those peculiar principles which give value to coal gas as a medium of artifical light; the peat gas is indeed scarcely capable of giving any amount of light, and when its lighting power is measured by the standard to which that of coal is referred, it is found not to be more than one third so great. It possesses, however, another quality in a higher degree than coal gas does,—its heating power is very intense.

Twenty or twenty-five years ago experiments were first made in Germany in connection with the manufacture of iron, in which an attempt was made to collect the gases which escape from the orifice or throat of the smelting furnace, and to employ them for puddling the iron. Since that time the subject has been kept under frequent experiment, with varying success, and at the present moment there are iron-works in which an immense amount of heating is done altogether by the combustible gases given off from the smelting furnaces. The gas from peat is more suitable to this than the gases from the iron furnaces. In the process of converting the peat into coke, as we have already seen, a large volume of highly combustible gas is obtained—the composition of this gas makes it obvious that its heating power must be very great, and if it were obtained in connection with metallurgical works, it might be applied to various purposes, at the same time the more valuable commodity—the peat coke—was being produced. As to the coke itself, it is suitable to all metallurgical processes if properly prepared, or rather if produced from properly prepared peat, and it is probably in respect to this part of the question, that most of the attempts to produce the coke have failed commercially. Common air dried peat is, generally speaking, not fit for conversion into coke, it is too spongy and porous, and the coke produced from it is light and fragile, easily crumbling down; even dense peat commonly air dried, does not produce a sufficiently compact and hard charcoal. In its normal state, peat holds water with great persistency, the water cannot be squeezed out of it, and as it spontaneously dries out it leaves the peat with a kind of cellular structure. If, however, the normal structure of the peat be broken down mechanically—that is, by violent attrition—the peat loses the power of retaining the moisture in the powerful manner of natural peat. And if peat thus broken down be moulded into any convenient form, it dries into a very hard, compact substance, free from the cellular structure already spoken of. If this prepared peat be burned in a retort, the coke which is left after the liquids and gases are expelled is dense, hard, and does not burn off in a furnace with an inconvenient rapidity. With regard to the application of peat-coke to the extraction and working of metals, it may be said that is in the highest degree to be recommended. Good peat contains only a very small per centage of ash—that is, of earthy matter—and this ash is, in most cases, free from those compounds of sulphur which operate so injuriously upon certain metals during the operation of extracting them from their ores. The effect of peat-charcoal in treating metals appears to resemble very closely that of wood-charcoal; and it is well known in peat districts that iron and steel forged with peat is better in character than that forged with coal.

The manufacture of peat-charcoal for metallurgical purposes is in all probability one of those subjects the advent of which is not far distant; and although in England we are blessed with such an abundance of fuel that we are careless in some degree of the advantages offered by peat or peat-charcoal in a manufacturing sense, the intrinsic merits of the question are such as to render it well worthy the attention of those concerned in metallurgical operations of any description.

A CRITICAL REVIEW OF THE CONSTRUCTION OF GIRDERS.

By J. J. Birckel.

A paper read before the Liverpool Polytechnic Society, 17th March, 1862.

(Illustrated by Plate 213.)

It is now about thirteen years since the world was for the first time startled with the news that a clear space of some 480 feet had been spanned with a tube, and that a railway train had been safely carried across it.

The circumstances, however, connected with the bold undertaking of carrying a line of rails across the Menai Straits are so universally known that it will be useless here to dwell upon them.

Since then wrought iron girder bridges, akin in construction with that over the Menai Straits, have been thrown across the widest rivers in almost every corner of the earth, and truly, the making of a railway bridge in these days has become a schoolboy's task.

I do not intend that this paper shall be an obstruse lecture on the theory of the resistance of girders, but I wish to let you have a glance at the divers modes of construction of girders adopted by different engineers and under different circumstances, and to look at the practical merits of each of them and inquire whether those merits which are claimed for them are founded on facts.

In order however to render clear in your minds the remarks which I intend to make on the various examples of girders before you, it will be necessary for me to lay down these fundamental truths.

First therefore :—

When a beam resting at each end upon a support is loaded between those supports, the action of this load and of its own weight cause it to take a certain deflection; and if we imagine a line drawn at mid depth of the beam lengthwise, all the fibres situate above that line are subject to a strain of compression and are shortened, while all the fibres situate below that line are subject to a strain of extension and are lengthened;—this literally does take place, and has been demonstrated by actual experiment. The greatest strain is borne by those fibres which, in a vertical direction, are farthest removed from the line drawn along mid length or from the middle fibre, and hence in all the examples before you the bulk of the resisting fibres is collected at the top and at the bottom of the girder. That strain, which of course increases in the same ratio as the sum of the load and weight of girder, is inversely proportional or decreases with the square of the depth of the girder, and decreases also in the same ratio as the horizontal distance from the supports or piers, until it reaches its minimum at the points where the girder just begins to rest on the supports, and where the fibres are subject only to a shearing strain, equal in amount to one half the sum of load and weight of girder.

Secondly :—

Where there is a continuous girder spanning over three, four, or more openings it is demonstrated that that girder will carry twice the load it would carry if each opening was spanned with an isolated girder. Continuous girders have in each opening two points termed points of nonflexion, or of contrary flexion; and it is demonstrated that at these points the fibres of the girder are subject to neither strains of compression nor extension, but simply to a shearing strain equal in amount to one half the sum of load and weight, corresponding to the length of girder extending between two consecutive points of contrary flexion; in fact the continuous girder is divided theoretically into twice as many detached or isolated girders as there are openings, each having a span equal to about one half that opening; and further, what may seem paradoxical, the continuous girder must be, on the supports or piers, as strong as it is in its mid length between two consecutive piers.

Having laid down these truths I shall now proceed to the critique of the examples of girders before us, and in doing so I shall take my stand upon the ground that the engineer should always endeavour to attain stability and durability with a minimum outlay of capital.

I have stated in the first place that girders are subject in their upper part to a strain of compression, and in the lower part to a strain of extension and if it be proved that wrought iron does not resist so well to compressive as to tensile strains, then, in order that the top may offer the same guarantee of resistance to breakage as the bottom, the sum of the fibres resisting at the top ought to be greater than the sum of fibres resisting at the bottom, or in other words, the area of the upper portion ought to be larger than the area of the lower portion, and that in the ratio of the difference between the resistance to extension and to compression. Experiments have proved that the proportion of resistance of wrought iron to extension and compression is about as 6 to 5; now let us see if this dictum of nature has been obeyed in the construction of the girders before us, and first let me remark that the vertical webs connecting the top and bottom flanges are never taken into account as elements of resistance to flexion, but only as a means of preserving the shape of the girders, and especially, of preserving the desired distance between the top and bottom flanges. Figs. 1 and 2, Plate 213, illustrate a girder which is being erected near Liverpool, and Figs. 3 and 4 a girder which is being erected in London; it will be perceived that in both these cases the top flange, instead of being larger than the bottom one, is actually smaller; they are of comparatively small span, and hence are only single webbed. Figs. 5 and 6 illustrate a girder of large span for a railway bridge.; Figs. 7 and 8 a girder of large span for a common road bridge for heavy traffic. In both cases the top flange is larger than the bottom one in the proportion of about 8 to 7; these were designed by Mr. Fairbairn of Manchester. Figs. 9 and 10 illustrate a girder for a bridge over the Rhine, designed by German engineers; and Figs. 11 and 12, a girder for a bridge in the South of France, designed by French engineers. In both these Girders the top and bottom flanges are equal in area. Continental engineers invariably allow, in the case of wrought iron, the same area for compressive as for tensile strains, and their argument for so doing is that, although wrought iron breaks sooner under compressive than under tensile strains, yet does it bear these strains alike well so long as the load it has to carry does not reach the limit beyond which the elasticity of the fibre is injured.

Reverting to Figs. 1 and 3, I must say that I should like to know on what grounds the bottom flanges have been made larger than the top ones, and am at a loss to find a plausible reason for it. Vainly also have I endeavoured to find out why in Fig. 3, the top flange has been put into a curved shape, for if the engineer who designed it expects to derive additional strength from it I am quite certain that he is doing worse than fishing in an empty pond, and am prepared to prove both by theoretical and by purely physical considerations, that he is losing strength: theoretically, because he actually reduces the depth of the beam, and physically because the plates in being thus dished have to be repeatedly heated in the air furnace and thereby loose a very material part of their strength. If, however, his object is to give the rain-water a chance to run down comfortably, then I must give him credit for a great deal of ingenuity, though indeed the object attained never will repay the additional expense incurred.

Mr. Fairbairn, it will be seen from Figs. 7 and 8, still adheres to the cellular construction of the top flange, though the only advantage to be claimed for it is a probability of sounder rivetting of the comparatively thin plates, than if the same were obtained by a series of plates closely packed; apart from that, it is a positive loss of strength, because it virtually reduces the depth of the girder.

The bottom flange, it will be seen, is made of plates closely packed, and the difference of area between the two is so small as to require a very small addition of thickness of plates to make up that difference.

I do not however wish it to be understood that I condemn the cellular construction as altogether useless, for I believe that in structures like the Britannia Bridge it is the only safe way of putting together the large masses of iron required, but I think that it to ought be confined to girders of such colossal dimensions.

I have previously stated that the strain on the resisting fibres of a girder decreases with the square of its depth, and according to that theory the depth of a girder might be increased until the area of the top and bottom flanges becomes a mere trifle.

Continental engineers who are generally speaking very good scholars, yet perhaps not so observant of facts in nature, are very strongly impressed with that theoretic truth, and the diagrams given in Plate 213 show that, while the depth of girders made by English engineers is only about one-thirteenth of the span, the depth of those made on the other side of the channel, is as much as one-tenth and one-ninth of the span; and again the webs which connect the top and bottom flanges and which are not considered as an element of resistance against flexion, as before stated, but simply as a means to preserve the shape of the girder, are now almost invariably reduced by continental engineers to a minimum, by making it in the shape of a lattice frame as shown by Figs. 9, 10, 11, and 12; while the engineers of the old English school continue to make them in the shape of solid walls made of rolled plates, strongly rivetted together, and stiffened by means of T iron. The consequence of this is, that the English girder will be heavier than the continental one, and in the same proportion more expensive, for, as a general rule, it may be said of works of this nature that the cost is proportional to the weight of metal. Circumstances, at a first glance, therefore, seem to militate in favour of a very deep girder, and of a web constructed in the shape of a lattice frame. In order, however, to realise practical truth we must leave purely theoretical ground, and, remembering that theories are based on certain premises, we must look whether in practice those premises are realised. Now the theory of the resistance of girders is based upon the premises that the girder is resting upon two unyielding supports and is loaded in some point or points of its length by certain weights or strains in a state of rest. But in the case of a bridge, every one knows that the latter hypothesis is not realised and that the girder is acted upon by a moving or rolling weight, which, in the case of railway trains especially, subjects the whole structure of the bridge to a number of vibrations which experience has proved to be fatal to all iron structures, and which accomplish their work of destruction in a space of time whose duration or extent is directly proportional with the number of fibres whose elasticity they have to destroy, or, in other words, is directly proportional to the amount of metal concentrated in the girder; and, that rolling weight subjects longitudinal girders also to a number of lateral strains, the absolute intensity of which theory has not so much as attempted to determine, but the effects of which are daily felt in practice. It is but twelve months since the very elegant wooden structure of the Dinting viaduct on the Manchester and Sheffield railway has been taken down and replaced by hollow iron girders, because it was threatened with ruin simply from the effects of lateral strains; and I have many a time witnessed the work of destruction by lateral strain going on, on the structure of a brick viaduct on the Manchester and Bury line of railway, where the engineers have had to tie the outer binding stones together by means of strong iron bars in order to prevent them being pushed out laterally. It is, mindful of these two facts, namely, the fact of vibration and the fact of lateral strains, that the wise men of this country adhere to the solid box girder in order, on the one hand, to oppose to the destructive effects of the first a greater bulk of fibres, and to the second the requisite equivalent of a top and bottom flange represented as regards them by the vertical webs of the girder. Besides this, the saving effected by great depths and by lattice webs is by no means so considerable as might be anticipated, and in one of the examples before us is actually a negative quantity. For instance, if we take the girder of the bridge over the Rhine (Figs. 9 and 10), the probable equivalent for it made by engineers in this country would be, calculating it on the data of the German engineers, of a maximum load of about two tons per lineal foot (its own weight included) and at one quarter the breaking weight, as follows: the depth, 14 feet; the area of top flange, 130 sq. in; the area of the bottom flange, 116 sq. in.; and the approximate weight of this girder would be 95 tons, if the area of the flanges is reduced to about one-half the above quantities on the points where the girder reaches the piers. Now I have carefully calculated the weight of the German girder illustrated before you, and to my great astonishment, I find it to be about 100 tons; this supposes the area of the flanges to remain constant throughout the length of the girder, which here really is the case; but even if the flanges were reduced at the piers to one-half the area in the centre, the weight of the girder would be about 88 tons—that is, only 7 tons lighter than its equivalent sketched out above; a very paltry saving, indeed, when the greater difficulty of construction of the lattice girder is taken into consideration. Altogether that bridge over the Rhine is very defective in construction, and practice already has demonstrated it. It consists of three girders similar to the one illustrated by Figs. 9 and 10, which are all three of the same depth, placed side by side, admitting a line of rails on each side of the middle girder, but the areas of the flanges of the outer girders are only half the areas of those of the inner girder; the lattice bars also are reduced in the same proportion, and under the heat of the sun, which acts quicker upon them than upon the larger masses of metal, they expand much more than the latter; in consequence of that those girders have warped so much as to alarm the engineers, who have found it necessary to stiffen them by means of longitudinal bands, A B, (Fig. 9). The flanges also are so narrow as to require seven layers of plates to make up the area, and cause the rivets to become 5 inches long between the heads; such long rivets are in danger of breaking from contraction after riveting and ought to be always avoided.

I have now to enquire into the practical value of the theory of continuous girders, which I have referred to in the earlier portion of this paper, the example of French engineering (Figs. 11 and 12, Plate 213) has been calculated and made in accordance with that theory. The points of contrary flexion have been calculated on the hypothesis of a stationary load, equally distributed, of about three tons per lineal foot, and under such circumstance are situate at a distance from the pier of about one-fourth the space between two consecutive piers. Here, again, theory rests upon a hypothesis which in practice is not realised, and the fact of a rolling weight, such as a railway train, passing over the bridge, causes the points of contrary flexion to shift so much as to render it very doubtful whether it is safe to establish a structure of this nature in strict conformity with any results which the theory in question may lead to. The French engineers, however, have actually done that, and have reduced the area of both flanges on the points of contrary flexion to about one-half the area in the middle of the span, or to about that area which an isolated girder would have on the piers. Let us now suppose that the continuity of the girder is not perfect, as the case unavoidably will be if it be not built up on the spot from end to end; for if it be built in lengths extending from pier to pier, which are afterwards either wheeled or lifted into their places, every boiler maker will agree with me that a perfect solidity between two consecutive portions has become an impossibility. Or else suppose that in one of the bays the girder has met with an accident which does at least temporarily destroy the continuity of the girder; then are the contiguous bays of the injured or decayed one in imminent danger of ruin, because the area of the flanges has now become too small by the amount of at least one half of their present value. Nor must it be said that the latter contingency is an imaginary one, for things built by the hands of man are all doomed to destruction, either by accident or by natural wear and tear. Let us now see whether the present saving effected is such as to justify engineers in running the risks which I have just pointed out to you. The weight of one bay of the girder (Figs. 11 and 12) is about 85 tons, and an isolated girder, calculated on the data of a maximum load of three tons per lineal foot (its own weight inclusive), at one-fourth the breaking weight, would assume about the following dimensions:—Depth, 15 feet; area of top flange, 186 square inches; area of bottom flange, 166 square inches—and the approximate weight of such a girder, built with solid webs instead of the lattice web, would be 105 tons. Here, then, we have a saving of 20 per cent. of present outlay to counterbalance the risks which I have enumerated, and the consequences of which are incalculable, as they involve both loss of capital and of human life. That saving of 20 per cent., however, you will remember is a saving of present outlay only; and if it be granted, as I have stated it, that the space of time required by vibrations to accomplish their work of destruction is proportioned to the weight of metal in the structure of the bridge, then it is very doubtful whether that saving of present outlay will be a saving in the long run of time, and it may reasonably be surmised that the items of increased expense in repairs, and of speedier destruction, will render that saving a positive loss in the end.

French engineers do not forget the fearful accident which happened some twelve years ago, when a whole battalion of infantry, marching with fixed bayonets, were precipitated into the River Loire by the sudden rupture of a suspension bridge, under the influence of great vibration; and when I remember that since then they have utterly condemned that description of bridges, and in many instances taken them down—I do not hesitate to say that the time will come also when lattice bridges, which are only a species of suspension bridges—and bridges of light construction in general, will be condemned in the same manner.

Before closing this paper, permit me to make a few remarks on beams for engines of great power, for the appalling accident at the New Hartley Pit renders the subject worthy of our especial attention. Cast-iron beams, as a means of transmitting the power of engines, have been almost in exclusive use to this day, although the wrought-iron box-girder has been known for thirteen years now. The reasons for the continued use of cast-iron beams may be stated thus:—1st. The cast-iron beam is replaced more readily than a wrought-iron one when once you have a pattern. 2nd. Its first cost is not as great as that of a wrought-iron one, and this very likely is the reason why wrought-iron has not come into more general use for this purpose. A movement in the right direction, however, had taken place long before this, and figures 13, 14, and 15 are sketches of a wrought-iron beam made by Messrs. Fairbairn for a pumping engine at Chester-Le-Street, in 1859. But it seems that some great catastrophe always seems to be required to make men fully alive to certain truths, or to cause them to abandon a cherished track: thus it required the almost complete destruction of a battalion of soldiers to make French engineers alive to the fact that suspension bridges are not safe; and here it has required the destruction of 200 miners to convince men that cast-iron beams for engines are not to be relied upon.

Figs. 16 and 17 represent an elevation and section of the beam that broke at the New Hartley Pit; and although so much has been written about it in various papers as to leave scarcely room for any further remarks, I will venture to make the few following ones. In the first place you will see that there is such a bulk of metal concentrated at the boss, which is 11 inches thick, that the adjoining comparatively thin parts must have been strained very much by contraction through cooling; the primary cause of fracture therefore, I think lies in this bad distribution of the metal; in the second place, it will be seen that the beam in reality consists of two distinct beams keyed upon one centre, and with such an arrangement it may just happen, either by a side jerk or otherwise, that the whole pressure be for an instant thrown upon one of the two halves of the beam only, and, this coupled with the defect already mentioned, would probably be sufficient to determine fracture.

Let us now compare this cast iron beam to its equivalent, constructed of wrought iron, on the principle of the one illustrated by figures 13, 14, and 15. Such a beam would assume the following dimensions:—Depth, 8 feet 6 inch; areas of top and bottom flanges 116 square inches; and its approximate weight would be 24 tons; taking the price at £20 per ton, its cost would be £480. Now the weight of the cast iron beam illustrated by figures 16 and 17, is about 47 tons, and taking the price at £8 per ton, its cost would be about £376.

Here then we have a saving of about 25 per cent. to counterbalance those risks, the effects of which are thrown into very bold relief by the catastrophe already referred to.

STRENGTH OF MATERIALS.

DEDUCED FROM THE LATEST EXPERIMENTS OF BARLOW, BUCHANAN FAIRBAIRN, HODGKINSON, STEPHENSON, MAJOR WADE, U.S. ORDNANCE CORPS, AND OTHERS.—BY CHARLES H. HASWELL, C.E.

(*Continued from page* 58.)

TABLE OF THE RESULTS OF EXPERIMENTS ON THE DEFLECTION OF BATTENS, BARS, BEAMS, AND GIRDERS OF VARIOUS SECTIONS AND MATERIALS; observed by Major Wade, U.S. Ordnance Corps, Barlow, Buffon, Fairbairn, Hodgkinson, Stephenson, &c.

Bar, Beam, &c., Supported at Both Ends, Weight or Strain applied in the Middle.

MATERIAL AND SECTION.	Length of bearing.		Breadth.	Depth.	Depth of opening.	Weight.	Deflection.	Value for general use. $\frac{l^3 W}{16 b d^3 D} = V.$
WOODS.	feet.	inches.	inch.	inch.	inch.	lbs.	inch.	
Fir. Rectangle	3	0	1·5	2·	...	120	·090	187
Square	4	0	2·	2·	...	420	·360	292
Rectangle	4	0	3·	1·5	...	120	·270	153
Ditto	6	0	3·	1·5	...	120	·937	170
Ditto	6	0	1·5	3·	...	120	·260	154
Ditto	6	0	1·5	2·	...	120	·680	198
Ditto	8	0	3·	1·5	...	120	2·045	185
Ditto	10	0	1·5	3·	...	120	1·050	177
Ash. Cylinder	3	10	2·	2·	...	715	2·700*	58
Hollow ditto	3	10	2·	2·	·5	657	2·500*	58
Square	7	0	2·	2·	...	75	·422	238
Ditto	7	0	2·	2·	...	225	1·266†	238
Yellow Pine. Square	5	0	·75	·75	...	16	1·500	250
"	5	0	·75	·75	...	40	6·250*	158
	5	0	1·5	1·5	...	16	·190	133
	5	0	1·5	1·5	...	16	·310	80
Square	7	0	2·	2·	...	150	1·134†	178
Elm. Square	6	0	2·	2·	...	125	1·685†	62
Beech. Square	7	0	2·	2·	...	150	1·026	196
Oak. Square	3	0	1·	1·	...	158	2·950	91
Ditto	7	0	2·	2·	...	150	1·590†	146
Ditto	6	0	2·	2·	...	200	1·280†	132
Ditto	15	0	5·35	5·35	...	6,000	8·570	180
Ditto	30	0	5·35	5·35	...	2,330	19·780	240
Rectangle	2	0	·75	1·5	...	323	1·500	43
Pine. Rectangle	40	0	7·5	9·25	...	1,700	5·250	218
 { Ditto	40	0	7·5	9·25	4·625	1,700	3·500	327
Ditto	40	0	7·5	18·5	9·25	1,700	2·250	63
Ditto	40	0	7·5	22·375	13·125	1,700	1·125	72
METALS.								
Cast Iron, English	2	10	1·	1·	...	300	·160†	2607
Ditto	2	10	1·	1·	...	1,008	·625	2278
Mean ditto	4	6	1·	1·	...	471	1·675	1589
Swedish††	3	0	1·	1·	...	884	·500†	2983
English. Square	4	6	1·	1·	...	56	·135	2551
Ditto	4	6	1·	1·	...	112	·259	2362
Ditto	4	6	1·	1·	...	448	1·535	1634
Ditto	4	6	1·	1·	...	440	1·779*	1132
Ditto	6	9	3·	3·	...	112	·012	2219
Ditto	9	0	2·	2·	...	112	·167	1910
Mean of mixture and blasts, square	4	6	1·	1·	...	481	1·366*	1992
English. Square	13	6	3·	3·	...	112	·092	2311
Rectangle	10	0	2·	1·	...	56	·480	3660
Ditto	13	6	3·	1·5	...	56	·323	2631

* Breaking weight. † Elasticity perfect.

‡ Barlow deduced from this that, as a mean, 1000 lbs. is the load that will destroy the elasticity of a bar of wrought iron 1in. square and 3ft. long between the supports; and Mr. Drewry assumes that a like bar will be deflected ⅓in. by 560lbs., and that it is not safe to load it permanently with 266 lbs.

TABLE OF THE RESULTS OF EXPERIMENTS ON THE DEFLECTION OF BATTENS, BARS, BEAMS, &c.—*continued.*

MATERIAL AND SECTION.	Length of bearing.		Breadth.	Depth.	Depth of opening.	Weight.	Deflection.	Value for general use. $\frac{l^3 W}{16 b d^3 D} = V.$
METALS—*continued.*	feet.	inches.	inch.	Inch.	inch.	lbs.	inch.	
Ditto	13	6	6·	1·5	...	56	·165	2573
American. Mean. 2nd fusion. Square	1	8	2·	2·	...	10,800	·117†	1656
3rd fusion. „	1	8	2·	2·	...	9,000	·088‡	1840
Chilled. „	1	8	2·	2·	...	10,800	·051‖	3821
Dry sand. „	1	8	2·	2·	...	10,800	·110	1761
Green Sand „	1	8	2·	2·	...	5,000	·045†	2000
2nd fusion. Cylinder	1	8	2·	2·	...	10,800	·161§	1205
	4	6	2·	1·43	...	168	·106	2467
Hot blast. Square	5	0	1·	1·	...	225	·110¶	1562
Cold blast. „	5	0	1·	1·	...	225	·085¶	2008
20 per cent. of wrought iron. Square	4	6	1·	1·	...	112	·202	3189
10 „ „ „	4	6	1·	1·	...	511	1·500	1940
2·5 „ of nickel „	2	3	1·	1·	...	860	·520*	1180
 Flange 5· × ·3 {	6	6	·36	1·55	...	112	·273	5302
	6	6	·36	1·55	...	336	1·030	4191
 Flange 5· × ·3 {	6	6	·36	1·55	...	112	·270	5302
	6	6	·36	1·55	...	336	·895	4850
 Flange 1·5 × ·5	3	1	·5	3·	...	672	·027	3360
 Flange 1·5 × ·5	3	1	·5	3·	...	672	·025	3609
 Flange 1·5 × ·5	3	1	·5	3·	...	2,016	·079	3534
 Flange 1·5 × ·5	3	1	·5	4·**	1·5	2,016	·051	2302
 Flange 1·5 × ·5	3	1	·5	3·**	1·5	2,016	·052	5364
 Flange 23·9 × 3·125	23	1	3·29	36·1	...	60,000	·100	2983
„ Flange 23·9 × 3·125	23	1	3·29	36·1	...	136,000	·230	2940
„ Flange 23·9 × 3·125	23	1	3·29	36·1	...	230,000	·420	2720
„ Flange 6·5 × 1·; area 18·5	15	0	·91	14·	...	4,480	·300	1261
 Flange 4·5 × ·875; 9· × 1·25	22	0	1·12	36·	...	22,400	·094	3034
„ Flange 9· × 1·625; 18· × 2·75	50	0	2·	36·	...	22,400	·187	9618
„ Flange 4·125 × 1·5; 15· × 2·25	30	9	1·5	24·5	...	{ 44,800	·469	7998
						72,000	·870	6817
 Flange 2·72 × ·83; 5·9 × 8·4; area 18·1	15	0	·68	17·25	...	4,480	·150	1808
 Flange 1·6 × ·315; 4·16 × ·53	4	6	·38	5·125	...	11,186	·400	3113
„ Flange 2·3 × ·28; 6·61 × ·54	4	6	·34	5·125	...	12,087	·260	5783
„ Flange 2·25 × ·33; 6·61 × ·74	7	0	·4	4·1	...	2,900	·250	9023
„ Flange 2·15 × ·24; 7·60 × ·72	4	6	·39	5·125	...	12,800	·250	5552
„ Flange 2·15 × ·24; 7·60 × ·72	9	0	·40	5·125	...	10,500	1·450	6128
 Rectangular, area 1·965	4	6	·975	2·015	...	712	·280	1817
 Open beam, area 2·	4	6	1·	2·5	·50	712	·132	1965
„ Open beam, area 2·	4	6	1·	3·	1·	712	·085	1766
„ Open beam, area 2·	4	6	1·	4·	2·	712	·040	1582

* Breaking weight. † Elasticity perfect. ‡ ·020. ‖ ·003. § ·022 ¶ Permanent set. ** Depth of opening, 3in.

TABLE OF THE RESULTS OF EXPERIMENTS ON THE DEFLECTION OF BATTENS, BARS, BEAMS, &c.—*continued.*

Material and Section.	Length of bearing.	Breadth.	Depth.	Depth of opening.	Weight.	Deflection.	Value for general use. $\frac{l^3 W}{16 b d^3 D} = V$.
METAL—*continued.*	feet. inches.	inch.	inch.	inch.	lbs.	inch.	
Curved bars, versed sine 1·44 in.	9 0	1·	3·	...	1,456	·38	6464
Curved bars, versed sine ·63 in.	9 0	1·	3·	...	1,778	·61	4919
Wrought Iron. Square	2 9	2·	2·	...	2,240	·068	2677
,,	2 9	2·	2·	...	4,480	·128	2748
Round	5 6·5	1·25	1·25	...	58	·125	1965
Rectangle	2 9	1·5	3·	...	2,240	·074	970
Swedish. Square	5 6·5	1·	1·	...	58	·125	4812
Flange 4·5 × ·5; rib 3·25 diam.	10 3	·5	10·	...	3,136	·375*	11258
Rib 3·5 × ·6	2 7	·8	3·5	...	6,720	·033	6384
Flange 2·75 × 1·; 4·3 × ·44	10 0	·35	8·	...	4,360	·12	12674
		·35	8·	...	12,980	·3	15058
Flange 2·85 × ·41	4 0	·29	2·5	...	1,960	·240	7209
Flanges, 2 of 2·25 × ·28 2 of 2·25 × ·3.	7 0	·25	7·	...	16,480	·250	16479
Flange 6 × ·375; 12 × 3·75 Angle iron, 2·5 × 2·5 × ·5 3·5 × 3·5 × ·5	28 6	·375	12·5	...	13,000	1·	2653
Flange 12 × ·375; 4 × ·375 Angle iron, 3 ·5 × 2·5 × ·375 1·75 × 1·75 × ·375	28 6	·375	12·125	...	20,700	2·250†	19911
Flanges 9 × 16 in.; Angle iron 4 ×	40 5	·75	24·	...	35,000	1·250‡	11196
Tubes. thickness ·03 in.	3 9	1·9	3·	...	448	·100	287
,, ,, ,, ·1325 in.	7 6	3·9	6·	...	4,376	·240	570
,, ,, ,, ·124 in.	30 0	15·	24·	...	5,685	·490	96
,, ,, ,, ·250 in.	30 0	15·5	23·75	...	5,685	·210	220
,, ,, ,, ·525 in.	30 0	15·5	24·	...	5,685	·120	372
,, ,, ,, top ·437 in. ,, bot. ·272 in.	30 0	15·75	23·75	...	33,685	·850	316
,, ,, ·037 in.	17 0	12·	12·	11·925	2,755	·650*	62
,, ,, ,, ·0954 in.	31 0	24·	24·	23·81	10,236	·630*	91
Box girder, with angle iron at angles. Top plates ·375, bottom and sides ·125	9 0	6·	6·	...	7,000	·250	984
Corrugated plates	31 6	·31	8·	...	4,480	·62	8893
Tubes, thickness, ·0416	17 0	9·25	14·62	13·535	2,262	·620*	38
,, ,, ,, ·143 in.	17 5	9·75	15·	14·714	16,800	1·390	123
Steel, Cast. Soft	3 2	·23	·52	...	22	·331	4245
Razor	2 2	·30	·57	...	22	·083	2984
Brass, Cast	1 0	·7	·15	...	60	·040†	1469
GUN METAL.							
Copper 8, Tin 1	1 0	·7	·5	...	100	·050†	1423

* Permanent set. † Ibid, ·4375. ‡ Breaking weight. ‖ Elasticity perfect. § Permanent set, ·625.

(To be continued.)

INSTITUTION OF MECHANICAL ENGINEERS.

DESCRIPTION OF RIVET-MAKING MACHINE.

BY MR. CHARLES DE BERGUE,

(*Illustrated by Plate* 212.)

The main feature of this machine consists in its making rivets by a continuous in motion, and its compactness and simplicity of action. The construction of the machine is shown in Plate 212. Fig. 1, is a front elevation of the machine, showing only the heading arrangement. Fig. 2 is a transverse section, showing the cutter for cutting the blanks previous to heading. Fig. 3, is a sectional plan. Fig. 4, is a side elevation; and Fig. 5, a longitudinal section.

The disc A, Fig 1, revolving on a horizontal shaft carries the dies for holding the blanks to form the rivets, of which there are eight in the circumference, marked BB in Figs. 6 and 7, revolving in the direction of the arrow. Figs. 8 and 9 show enlarged sections of the dies. The cast-iron header C, shown enlarged in Figs. 10 and 11, by which the heads of the rivets are formed, is carried by the crank D, fixed on a second horizontal shaft, revolving eight times for once of the disc A, and so geared with it by the toothed wheels E F, Fig, 3, as to coincide exactly with the eight dies as they successively pass before the header C at the moment of its full stroke towards the disc. At this time the disc carrying the dies and the header are for a moment travelling together. The end of the bar carrying the header C slides in a slot G in the ring H, which revolves freely upon the centre pin I of the disc. The inner half of this ring H is turned eccentrically, as shown in Figs. 6 and 7; and upon it a loose ring K is placed, which takes the thrust of the pins for holding up the rivets during the heading and forcing them out of the dies when completed. The eccentric is held in a fixed position, or nearly so, by the end of the header bar sliding through the slot G, the eccentricity being set not quite opposite to the point where the heading takes place, so that the moment the header has left the die, the eccentric begins to act in forcing the rivet out. The loose ring K always moves with the pin which holds up the rivet while the heading is being performed and also while forcing out the rivet, and thus throws the wear upon the whole service of the eccentric, instead of confining it to the portion directly under the header.

To prevent the possibility of accident to the machine from blanks being put into the dies too cold or too large in size, the header C is supported behind by a small crushing piece of cast iron L, shown enlarged in Figs. 12 and 13 which lies free in a recess in the header bar. This crushing piece is made of such sectional area to resist the nsual crushing strain required for heading a rivet, but to yield by crushing if by any accident a cold rivet blank or any other unyielding substance should get between the header and the die, forming a complete protection against injury of the machine by overstrain in working. Fig. 13 shows the manner of fracture of one of the crushing pieces.

During the time of the header being in action, the motion of the header and the die as governed by the toothed wheels E and F would no be perfectly coincident, except at the beginning and end of the heading process. At the point where the process commences, which is a point adjustible at option, the centre line of the header, as carried forward by the toothed wheels coincides with the centre line of the rivet to be headed; then proceedings in the direction of the rotation, the rivet over-runs the header slightly, and again exactly coincides with when on the centre line or line of greatest pressure; after which the reverse action takes places as the header receedes from the die. The motions of the header and the die are, however, made perfectly coincident throughout by means of a steel pin M, Fig. 3. inserted in the header bar alongside of the header; and eight corresponding holes N to receive this pin are bored in the circumference of the disc, Figs. 3 and 4, side by side with the holes which contain the dies. The pin M enters the hole in the disc at the point where the heading process commences; and the teeth of the driving pinion E are at the same time partially cut away, so as to clear the teeth of the larger wheel F while the pin is in action; and then as the pin leaves the hole in the disc, the teeth of the pinion again take up the driving action and continue the movement of the disc. Thus the die is carried forward during the heading progress by the pin M, independently of the teeth of the pinion, which are not required at that part of the rotation for working the machine; but they are still retained in order to keep the wheels in gear throughout the entire revolution, and are left strong enough to carry on the motion safely even without the pin M.

The bars for making the rivets are heated in a furnace alongside the machine, and are then cut off to the required lengths by a lever cutter O, Fig. 2, driven by a double cam on the heading shaft, thus allowing two lots of rivets to be cut for one rivet made, and so giving time for changing the bars while still a sufficient supply of blanks is always kept cut; 4 to 6 blanks are cut off in each batch, about 10 bars being kept in the furnance at once. The blanks are fed into the dies by two boys, a third boy doing the cutting. The lengths to be be cut off are regulated by an adjustable bar P, Fig. 2, sliding upon a pin and moved backwards or forwards by a screw.

The first motion is given to the machine by a belt upon the pulley R, Fig, 3, and thence through the pinion S and spur wheel T. The framing at the front of the machine is made exceedingly strong, for resisting the strain of tension thrown upon it during heading; while the back frame on the contrary is arranged to receive the compression strain of the tail ends of the shafts.

The machine is placed close by the side of the furnace, so that the heated bars have only to be carried about 2 feet distance from the furuace mouth to the cutter, and the ends cut off fall into a trough, down which they run to a convenient position for the boys who feed the dies. The finished rivets fall out below the disc into a truck placed to catch them, and are thence wheeled away. The machine is speeded according to the size of rivets to be made: thus for 1 inch rivets the disc revolves 4 times per minute, making 32 rivets per minute; and for $\frac{1}{2}$ inch rivets the disc revolves 5 times per minute, making 40 rivets per minute.

The objects aimed at in applying machinery to rivet-making are, more uniform and perfect manufacture of the rivets, and a more rapid production than by hand making; together with the independence of the risks of delay in the supply by hand work when large quantities are required. But from the simple nature of the work, and the small margin of economy in manufacture by the application of machinery, only a very simple and durable machine is suitable for the purpose.

The advantrges found in the machine now described are that by the continuous motion a saving of time is effected, and a larger quantity of rivets are produced in a given time; while the shocks and concussions attendant upon stopping and starting the motion, with the consequent jar and destructive wear and tear, are avoided, increasing the durability of the working parts. The use of the crushing piece also behind the header serves as an effectual safeguard against breakage, and prevents the strain that can be put upon the machine ever exceeding the intended limit, which for making 1 inch rivets is taken at about 20 tons. The whole machine also lies in a compact and convenient form, taking up a space of about 5 feet by $9\frac{1}{2}$ feet, as shown in the plan, Fig. 3, and only about 8 feet by $9\frac{1}{2}$ feet total space, including the heating furnace.

The heating furnace is of a compact and convenient construction, 3 feet long by $2\frac{1}{2}$ feet wide in the body, with a fire at the back end The flame passes over the bars to be heated, and down a flue at the front end, just within the drawing-out door, thus avoiding any cooling effect on upon the bars when the door is opened, and keeping up a very uniform heat.

ON THE STRENGTH OF STEEL CONTAINING DIFFERENT PROPORTIONS OF CARBON.

BY MR. T. EDWARD VICKERS, OF SHEFFIELD.

(*Illustrated by Plate* 209).*

Three most important materials of British manufacture—wrought iron, steel, and cast iron—are combinations of iron with a smaller or larger amount of carbon. Wrought iron contains from about $\frac{1}{4}$ to $\frac{1}{2}$ per cent. of carbon, cast steel about $\frac{3}{8}$ to 2 per cent., and cast iron from $2\frac{1}{2}$ to 7 per cent. The great variety of opinions that have been expressed respecting the strength of steel when containing different proportions of carbon led the writer to make a number of tests upon this point, the results of which are given in the present paper with the conclusions derived from them.

The degree of carbonisation in the several varieties of steel tested in the experiments ranged from about $\frac{1}{3}$ per cent. of carbon to $1\frac{1}{4}$ per cent.; the softest or least carbonised steel containing $\frac{1}{3}$ per cent. of carbon was called No. 2, and the hardest or most highly carbonised containing $1\frac{1}{4}$ per cent. of carbon No. 20. the intermediate numbers representing intermediate degrees of carbonisation. The tests to which the steel was subjected consisted in ascertaining its tensile strength, by means of bars of the steel broken by direct tension; and also its transverse strength, by means of axles made of the steel which were broken by the blows of a heavy ram.

Tensile Strength.—The tensile strength of the several varieties of steel was tested by the simple lever machine shown in Plate 209, in which the leverage is 220 inches to 11 inches, or 20 to 1, (Fig. 1), so that each cwt. added in the scale at the long end of the lever produces a tension of 1 ton on the test bar at the other end of the lever. The test bars A, Figs. 2, 3, and 4, are $21\frac{1}{2}$ inches long, with 14 inches of their length turned down to a uniform diameter of 1 inch. For facility of fixing the bars in the testing machine and removing them when broken, the ends are made wedge-shaped, and the lower end is held in a conical socket in the holding-down block B, into which it is inserted through the longitudinal slot shown in the plan, Fig. 6; the bar is then turned half round, and the upper end slipped into the wedge-shaped holder C at top, whereby the bar is securely held during the testing. The following Table I. gives the results of the trials, showing the breaking strain reduced to tons per square inch, together with the amount of elongation produced in the bars:—

The elongation was measured after each addition of load in the scale at the long end of the lever; and that given in the table is the final amount of elongation, previous to adding the last cwt. in the scale which caused the breakage.

* Given in THE ARTIZAN of last month.

Table I.—Tensile Strength of Steel containing different proportions of Carbon,

Description of Steel.	Proportion of Carbon (approximate.)*	Breaking strain per square inch.	Elongation.
	Per cent.	Tons.	Inch.
No. 2	0·33	30·4	1·37
No. 4	0·43	34·0	1·37
No. 5	0·48	37·5	1·25
No. 6	0·53	42·5	1·12
No. 7	0·58	41·5†	0·81
No. 8	0·63	45·0	1·00
No. 10	0·74	45·5	0·69
No. 12	0·84	55·0	1·12
No. 15	1·00	60·0	1·00
No. 20	1·25	69·0	0·62

* The intermediate figures in this column, from No. 4 to No. 15 inclusive, are merely approximate, being interpolated in proportion to the numbers of the steel.

† There was a flaw in this test bar, which will account for its breaking at a lower strain than the preceding No.

The table shows that the tensile strength of the steel is increased by the addition of carbon, until it is combined with about $1\frac{1}{4}$ per cent. of carbon, when it sustains about 69 tons per square inch. But beyond this degree of carbonisation the steel becomes gradually weaker, until it reaches the form of cast iron, which sustains a tensile strain of only about 6 or $6\frac{1}{2}$ tons per square inch. When the test bar is turned down at one point only, instead of through a considerable length, the result obtained has been found to be different; for a bar of steel turned down to $\frac{3}{4}$ inch diameter at one point only, as shown at D in Fig. 5, did not break till the strain reached $79\frac{1}{2}$ tons per square inch: whereas a bar of the same steel turned down to 1 inch diameter for 14 inches of its length broke with a tension of 60 tons per square inch.

Transverse Strength.—For testing the transverse strength of the several varieties of steel, axles were made of the steel in the various degrees of carbonisation, which were subjected to the blows of a heavy ram until broken. The axles were all turned to 3·94 inches diameter at the centre and 4·25 inches at the ends, and were supported on bearings 3 feet apart, as shown in Figs. 7 and 10, Plate 209; they were reversed at intervals when considerably bent by the blows of the ram, as shown by Figs. 8 and 9. The ram weighed 1547 lbs. or nearly 14 cwts., and was dropped on the centre of the axle from a height commencing at 1 foot and increasing at each successive blow up to 36 feet fall, unless the axle was broken at a previous blow.

Table II.—Detail of Experiment on Transverse Strength of Axle made of No. 4 Steel.

No. of Blow.	Height of Fall.	Deflection. Before Blow.	After Blow.	Effect of Blow.
	Feet.	Inches.	Inches.	Inches.
1	1	— 0·00	⌣ 0·19	0·19
2	2	⌣ 0·19	⌣ 0·53	0·34
3	3	⌣ 0·53	⌣ 1·12	0·59
4	4	⌢ 1·12	— 0·00	1·12
5	5	— 0·00	⌣ 1·19	1·19
6	$7\frac{1}{2}$	⌣ 1·19	⌣ 2·19	1·00
7	10	⌢ 2·19	— 0·00	2·19
8	$12\frac{1}{2}$	— 0·00	⌣ 2·19	2·19
9	15	⌢ 2·19	⌣ 0·75	2·94
10	20	⌢ 0·75	⌣ 3·00	3·75
11	25	⌢ 3·00	⌣ 1·50	4·50
12	30	⌢ 1·50	⌣ 3·81	5·31
13	36	⌢ 3·81	⌣ 2·37	6·19
14	36	⌢ 2·37	⌣ 3·75	6·12
15	36	⌢ 3·75	⌣ 2·31	6·06
16	36	⌢ 2·31	⌣ 3·88	6·19
17	36	⌢ 3·88	⌣ 2·25	6·13
18	36	⌢ 2·25	broken	...
			Sum of Deflections	56·00

Table II. gives the detail of the experiment on an axle of No. 4 steel, containing about $\frac{4}{10}$ per cent. of carbon; showing that it stood 5 blows of the ram falling from 36 feet height before breaking, after 12 blows from lower heights of fall, and the sum of all the deflections produced by the blows amounted to 56in.

Table III. gives the general results of the series of experiments made in a similar manner to the above, with axles of the several varieties of steel; showing the total number of blows required to break each axle, the number that it sustained with 36ft. fall of the ram before breaking, and the sum of all the deflections produced. Three wrought iron axles were also tried in the same way, one of the best faggotted axles that could be procured, and two scrap iron axles.

Table III.—Transverse Strength of Axles made of Steel containing different proportions of Carbon.

Material of Axle.	Proportion of Carbon. (approximate.)*	Total number of Blows.	Height of Fall in last Blow.	Number of blows sustained from 36 feet height.	Sum of Deflections.
	Per cent.		Feet.		Inches.
Steel No. 2	0·33	17	36	4	58·81
No. 4	0·43	18	36	5	56·00
No. 5	0·48	18	36	5	53·56
No. 6	0·53	15	36	2	35·06
No. 7	0·58	16	36	3	38·81
No. 8	0·63	18	36	5	46·00
No. 10	0·74	16	36	3	40·31
No. 12	0·84	10	20	0	8·56
No. 15	1·00	8	$12\frac{1}{2}$	0	4·31
No. 20	1·25	10	20	0	6·94
Best wrought iron	...	13 **	36	0	31·19
Scrap iron	...	5	5	0	2·00
Scrap iron	...	5 †	5	0	3·69

* The intermediate figures in this column, from No. 4 to No. 15 inclusive, are merely approximate, being interpolated in proportion to the numbers of the steel.

** Cracks began to show at the tenth blow, with 20 feet height of fall, and increased at each subsequent blow.

† Two large cracks opened at the fifth blow, therefore it was considered practically broken.

From these experiments it appears that, for bearing sudden and heavy blows, without regard to rigidity, the metal cannot contain too little carbon, provided it be pure and there be perfect cohesion of the particles. These qualities, however, cannot exist to the required degree in wrought iron or puddled steel, as shown by the experiment with the wrought iron axle in the above table; and are to be found only in cast steel, which must contain at least enough carbon to render it sufficiently fluid in melting. The steel melting process alone can effectually rid the metal of the impurities that were contained in the iron from which it is made.

There is nothing more deleterious to iron or steel than overheating or too many heatings, and the writer believes that all welding affects the quality of the metal more or less injuriously. Cast steel has the great advantage of being less liable than any other metal in general use to become crystallised by vibration. It has already a natural crystal, and the result of the writer's experience is that its crystal can be changed into a weak form only by being overheated. Cast steel and Swedish wrought iron have been placed where they were subjected equally to continual blows, concussions, and vibrations; and the cast steel was found to stand for a long period without change of crystal, where the Swedish iron broke very soon, showing great changes in its form of crystallisation.

For most mechanical purposes the best material in practice is one that combines the power of resisting a tolerably high tensile as well as transverse strain; one that will bear a tension of about 45 to 50 tons per square inch will generally be quite strong enough, and will be below the point at which brittleness from too great rigidity begins. The following Table IV gives a comparison of the preceding Tables I and III, and shows that such a material is found in the steel Nos. 8 to 10, containing about $\frac{5}{8}$ to $\frac{3}{4}$ per cent. of carbon. There are of course purposes where a specially ductile or specially rigid material should be employed, but the latter should be used only in cases where it is not liable to sudden concussion.

TABLE IV.—TRANSVERSE AND TENSILE STRENGTH OF STEEL CONTAINING DIFFERENT PROPORTIONS OF CARBON.

Description of Steel.	Proportion of Carbon. (approximate)*	TRANSVERSE. Sum of Deflections.	TENSILE. Breaking strain per square inch.	Elongation.
	Per cent.	Inches.	Tons.	Inch.
No. 2	0·33	58·81	30·4	1·37
No. 4	0·43	56·00	34·0	1·37
No. 5	0·48	53·56	37·5	1·25
No. 6	0·53	35·06	42·5	1·12
No. 7	0·58	38·81	41·5	0·81
No. 8	0·63	46·00	45·0	1·00
No. 10	0·74	40·31	45·5	0·69
No. 12	0·84	8·56	55·0	1·12
No. 15	1·00	4·31	60·0	1·00
No. 20	1·25	6·94	69·0	0·62

*The intermediate figures in this column, from No. 4 to No. 15 inclusive, are merely approximate, being interpolated in proportion to the numbers of the steel.

The superior strength of cast steel cannot be better illustrated than by stating that castings of steel, without hammering, rolling, or other means of mechanical compression, show a very high degree of strength and tenacity, far above that of castings of any other metal in practical use. Advantage is taken of this property to make bells of cast steel, one third lighter than bronze bells of the same diameter; and these lighter steel bells still bear double the breaking strain of the bronze ones. Another feature in the superior strength of castings in steel is that they are not so liable as other metals to break when subjected to concussions during intense frost, as proved by the fact that the cast steel bells have been rung without the least injury in Russia and Canada, when the thermometer ranged lower than 20° below zero Fahr.; while the heavier and thicker bronze bells could not be rung in the same temperature without cracking.

The same properties have also led to the manufacture of cast steel disc wheels with tyres in one solid body, for railway carriages and engines. One of these disc wheels was tested in the manner shown in Fig. 11, Plate 209: the wheel was put upon an axle fixed firmly in bearings at each end, and the ball E weighing 830lbs. or nearly 7½ cwts., suspended by an iron rod 24 feet long, as shown in the drawing, was drawn back and let fall so as to strike the wheel on the outside of the rim or tyre. The wheel was struck nine blows increasing from 1 foot to 14 feet in vertical height of fall, after which the axle was so much bent that the ball could not strike the wheel. The axle was then straightened by striking the wheel on the opposite side, and was propped up to prevent bending again; and two more blows were struck from the height of 15 and 16 feet, without causing any damage to the wheel,

The results of all the experiments that have been described show that cast steel, which even to the present time is considered by many a brittle material, fit only for a cutting instrument, is in fact a metal having not only all the good and desiraale properties of wrought iron in a higher degree, but at the same time freedom from most of the objectionable properties of the latter, and admitting of being employed for every mechanical purpose where great ductility, tenacity, and transverse strength, are required.

In reference to the specific gravity of steel as affected by the proportion of carbon it contains, chemists and scientific writers have generally given the specific gravity of steel as about 7·850 and of wrought iron about 7·650, that of water being 1·000; which leads to the inference that the addition of carbon to iron has the effect of increasing its density, and such is the general opinion at present. The contrary however has been found by the writer to be the fact, namely that pure iron decreases in density the more carbon there is combined with it. The low specific gravity of wrought iron above stated must therefore have been obtained from common English merchant iron, a piece of which gave a specific gravity of 7·644, which very nearly agrees with that above mentioned; and must be owing to the impurities contained in the iron. The specific gravity of one of the purest and softest Swedish irons is 7·894; and that of the iron from which the steel was made for all the experiments that have been described above is about 7·860. Table V. gives the specific gravities as ascertained by experiment of the successive gradations of steel, from No. 2 containing about ⅓ per cent. of carbon, up to No. 20 containing about 1¼ per cent., the results having been all obtained with pieces of metal of considerable size, varying from 2¾ to 4½ oz. in weight.

The specific gravities of the steel No. 2. and No. 4 are here seen to be greater than that of the original iron; but this may be attributed to the iron being freed from impurities in the melting. The conclusion therefore derived from the above figures is that every successive addition of carbon to pure iron renders the metal less dense or diminishes its specific gravity.

Mr. Vickers exhibited a number of strips of steel plate $\frac{5}{16}$ inch thick, which had been tested to show how far they could each be bent before cracking, when containing different proportions of carbon. Also a large cast steel pinion, and one of the steel axles that had been tested. After testing the axles, he had rolled down the broken pieces into plates $\frac{5}{16}$ inch thick, and tried them by bending, as shown by the other specimens exhibited. The softest steel, called No. 2 in the tables of experiments, had a tensile strength of only 30 tons per square inch, but the test plate made of it bore bending double without cracking, showing a great degree of toughness; while the most highly carbonized quality No. 20, had the greatest tensile strength, amounting to 69 tons per square inch, but was so brittle that it snapped asunder without bending more than about 45° out of the straight line, as shown by the specimen exhibited. For the experiments on axles, in order to obtain the most correct results from wrought iron axles for comparison with those of steel, he got the best wrought iron axle he could of the regular faggotted make from a railway company, and also two scrap axles from makers who knew they were going to be tested; but the last two turned out worse than had been expected, and much inferior to the first, as seen from the table of experiments.

One circumstance to be noticed respecting the mode of testing the tensile strength of bars was that the results obtained with long test bars were different from those given by short ones. In a number of experiments upon this point he had found it to be regularly the case that if the test bar were turned down to the required diameter at one point only of its length it would stand one third more strain than if turned down to the same diameter throughout a length of 14 inches. This was a fact of much importance, as affecting the value of many experiments.

TABLE V.

SPECIFIC GRAVITY OF STEEL CONTAINING DIFFERENT PROPORTIONS OF CARBON.

Description of Steel.	Proportion of carbon (approximate.)*	Specific Gravity.
	Per cent.	
Swedish Iron, pure and soft	...	7·894
Iron from which the Steel was made	...	7·860
Steel No. 2	0·33	7·871
No. 4	0·43	7·867
No. 5	0.48	7·855
No. 6	0·53	7·855
No. 7	0·58	7·852
No. 8	0·63	7·848
No. 10	0·74	7·847
No. 12	0·84	7·840
No. 15	1·00	7·836
No. 20	1·25	7·823
Puddled Steel, for melting purposes	...	7·824
Cast Iron, mean of best authorities	2½ to 7	7·204

*The intermediate figures in this column, from No. 4 to No. 15 inclusive, are merely approximate, being interpolated in proportion to the numbers of the steel.

INSTITUTION OF CIVIL ENGINEERS.

RAILWAY ACCIDENTS—THEIR CAUSES AND MEANS OF PREVENTION, SHOWING THE BEARING WHICH EXISTING LEGISLATION HAS UPON THEM.

By MR. JAMES BRUNLEES, M. INST. C.E.

The Author proposed to treat the subject by dealing with the facts as they were, the causes of accidents being, in nearly all cases, sufficiently apparent; he would not, therefore, attempt by theory, to establish rules for their prevention. From the reports of the officers of the Board of Trade it appeared that, during the seven years from 1854 to 1860, the number of accidents amounted to 540, as the result of 1274 distinct causes. Of the accidents 11 per cent. were attributed to the permanent way, 7 per cent. to the rolling stock, and 76 per cent. to the management, including insufficient means for securing safety, leaving only 6 per cent. as not ascertained.

The accidents due to the permanent way were then referred to in detail, and it appeared that the general defects were most evident in the system of ballasting, joint-fishing, of turning the rails, and of fastening the chairs to the sleepers. With regard to the ballast, it was argued that it would be found economical to have at least 6 inches, or 9 inches, of rough gravel, or broken stone, as a free draining bed to the sleepers and to the "top-dressing;" and that, during the months of September and October, an extra number of men should be employed to drain the ballast and beat up the road, in order that it might become consolidated before the winter's rains and frost set in, and thus avoid the effects of frost or wet ballast. It was urged that the plan, now in general use, of placing the fish-joint between two sleepers was objectionable, as the ends of the rails were unsupported except by the fish-plates, which together were frequently only equal to two-thirds of the section of the rail. It was submitted that all the joints should be fished directly over a sleeper, or that a bracket chair should be used. The practise of turning the rails was condemned, because when a rail was so much worn as to require turning, its strength was generally so reduced as to render it unfit for main line traffic. With regard to the fastenings of the chairs to the sleepers, it was urged that it was desirable that iron spikes only should be employed on the outer side of curves, or else that the chair should be partially sunk into the sleeper, to lessen the strain on the trenail. The superior economy of steeled, or partially steeled, rails, points, and crossings, was also incidentally noticed.

In reference to the accidents which had arisen from defective, or neglected rolling stock, it was found that many of the fractures had occurred during the winter months, owing, possibly in some degree, to the rigid state of the "way" in frosty weather; whilst others were due to the use of bad iron, and some to defects either in the welding of, or in the mode of attaching the tyres of the wheels. Steel, or partially steeled, tyres were now, to a certain extent, in use, and tyres formed of a continuous ring, or unwelded piece of metal, were also successfully employed. Several new methods of fastening the tyres had proved as fruitful of mischief, as the ordinary plan of simply shrinking them on, though others had been found to be efficient; and it was said that on some lines the tyres had not failed to any great extent. The Author hoped, that the importance both of the tyres and of the axles of wheels would lead to a useful discussion on this branch of the subject. The usual want of uniformity in the main features of the carriage portion of the rolling stock was then commented upon: and it was considered that this variety not only increased the cost of manufacture and frequently contributed to render them disastrous. The Author thought that the carriages should be nearly uniform in size, and that the buffers should, in all cases, be the same height above the rails. The longitudinal beams should be in the same line throughout, be strong in themselves, and the framing securely braced. The present coupling in the centre should be increased in strength, and the whole attachment between the carriages should be such as to render a train in effect, as far as practicable, as one carriage, with a certain amount of flexibility; so that in the event of collision the carriages, should retain their position, instead of rising upon one another; if an axle, or a wheel broke, the crippled carriage should be partially borne up by neighbouring carriage until the train could be stopped.

On the question of Management, after some remarks upon the speed of trains, it was shown that by punctuality, both in the time of starting and in the rate of running, safety, so far as human foresight was concerned, was ensured. The system of working the traffic of a railway by allowing an interval of time between the trains was deemed unsatisfactory, and far inferior to the system of an interval of space. The accidents arising from the irregularity of excursion trains were then alluded to, and it was remarked that if, during the summer and autumn, tho ordinary trains were run at lower rates of fares, the traffic would be increased, as the public would feel greater security in travelling. The difficulty in running coal or mineral trains to a fixed time-table might be met by a more general use of the electric telegraph, and by a better system of signalling arrangements. During the seven years, from 1854 to 1860 inclusive, 88 accidents happened from inefficient signals, of which 14 occurred in 1860. In some cases, especially at sidings, there were no signals; in others they were defective in form, or were improperly placed. It was desirable that junction signals and points should be worked simultaneously by one man, and at junctions, separate main and distance signals should be probided for each line. If the system of working the traffic by the electric telegraph was generally adopted, and the line was divided into sections, so that a train should be prevented from entering any section until the preceding one had passed to the section in advance, collisions would be impossible, except those liable to arise from disregard of the signal, and a proper interval would be securred between the trains, in spite of unpunctuality. As the want of of a meaus of communication between the engine-driver and the guard, or conductor, had frequently been experienced, and as plans were in daily use on several lines, there was no reason why it should not be adopted on all. To render it fully effective, the guard, or conductor ought to start the rain from each station by means of that machinery, so as to prove that it was in working order. Owing to the general high speeds and heavy trains, it was of the utmost importance that ample break power, capable of being applied in the lerst time, should be provided with each train. It was a question how far a regularly distributed retarding force, acting at the same moment on all the wheels, might not be preferable to a concentrated force applied at particular points. By the system of "continuous breaks," the employment of several men with each train was unnecessary. It had also another advantage, that a train was more under control, and could be stopped in a shorter distance. The negligence of servants, arising from their ignorance or inefficiency, was next adverted to, and it was thought to be due to the pay being too low to command the services of men of intelligence, steadiness, and self-reliance. Frequently they were insufficient in number, leading to overwork, and instances were on record in which engine-drivers had been employed for seventeen hours daily, and in some cases for twenty-six and thirty hours continuously.

The author proposed leaving the bearing of existing legislation upon railways to be dealt with by Captain Douglas Galton. He would, however, observe, that Government interference was not likely to render railways safer, or more available to the traveller; and that it would be better to rely on the consideration and calm reflection of those immediately interested in these enterprises, especially as from the heavy expenses attendant on accidents, directors and shareholders would naturally desire to render this mode of travelling as safe as possible.

The second Paper read was on "Railway Accidents," by Captain Douglas Galton, R.E., F.R.S., Assoc. Inst. C.E.

It was stated that the length of railway communication opened in the British Isles at the end of 1860, was 10,433 miles, upon which 163,435,678 passengers were conveyed in that year. From official returns it appeared, that during the seven years ending the 31st December, 1860, there were 116 passengers killed, and 2832 injured, from causes beyond their own control. From the sums paid by railway companies for compensation, it was calculated that an insurance of one twenty-fourth part of a farthing per passenger per mile would, on the average of all lines, cover the coast of railway accidents, It had been found impossible to obtain reliable informatiom, as to the number of coach accidents in this country. But the returns of the "Messageries Impériales" showed, that in a series of years, the number of passengers killed and injured, from causes beyond their own control, was 1 in 28,000. From the latest comparative returns, the number of passengers killed and injured was on British railways 1 in 334,000, on Belgian railways 1 in 1,600,000, on Prussian railways 1 in 3,000,000, and on French railways 1 in 4,000,000. The greater comparative safety of foreign railways was traced to differences in the conditions of the traffic and of the management, as well as in the habits of the people.

In endeavouring to elucidate the question, whether any of the accidents which had occurred could have been prevented by reasonable precautions the first point which arose was, the extent to which the amount of traffic on the several lines influenced the number of accidents. The general averages thus obtained showed, that lines of small traffic were comparatively safe. But as traffic alone did not determine the number of accidents, it was necessary to analyse the causes in detail; taking, first, those which were within the control of the managing, or working staff. During the seven years before referred to, 534 accidents to trains had been reported upon by the Inspecting Officers of the Board of Trade, in which 2912 passengers were killed, on injured. In many of these cases there had been more than one contributing cause, but the majority might be thus tabulated:—

	Number of Accidents reported upon.	Number of Sufferers.	Cases in which the Accidents could not be guarded against.	Cases in which the Accidents were due to Causes within the control of the Management.		
				Attributable to the Works or Rolling Stock.	Attributable to the system of Working.	Negligence of Inferior Servants.
Accidents from Engines and Carrriages leaving the Rails or Fractures of Machinery	135	313	59	98	15	17
Collisions of every description..........................	319	2,532	16	222	219	183

These figures showed that a large proportion of the so-called accidents were due to preventible causes. Those arising from the fracture of axles and tyres, and from engines and carriages leaving the rails, were less than one-half of the number which could not have been guarded against. But out of the 319 collisions, only 16 were attributable to purely accidental causes, whilst 183 were assigned to the negligence of inferior servants, and which ought not, therefore, to have occurred.

With regard to the first class of cases, accidents which could not have been guarded against, the author remarked, that the best form of tyre for a railway wheel had not yet been definitely settled. The wheels and axles could scarcely be said to be mechanically satisfactory; the form of break in use was also imperfect. Although simple negligence could not be entirely prevented, yet in several cases the negligence had been attributable to the defective arrangement of the company, in permitting pointsmen and engine-drivers to be habitually over-worked. Those accidents which arose from trains passing on to a wrong line through facing-points, might not have occurred, if an indicator had been attached to the points, to show in which direction they were set. The comparatively small number of accidents from negligence alone afforded strong evidence of the efficacy of the direct responsibility of the inferior servants. A few instances were then cursorily alluded to, in illustration of those accidents which were wholly, or partially attributed to defects in the condition of the railway, or vehicles, or to the absence of the requisite auxiliaries to safety, such as signals, breaks, &c, It was observed, that it was not for want of good rules that accidents occured, but for want of a continued enforcement of those rules, and a close examination into the details of the manner in which the traffic was worked.

The discussions which had taken place on this subject in Parliament, both in 1853, and again in 1857, were then considered, and the conclusion was arrived at, that freedom from railway accidents was not to be obtained by Government interference, but by an effective and responsible internal management, which would enforce the greatest punctuality and care in working the traffic, and maintain the strictest discipline amongst the servants employed.

The existing law, affecting railway companies as carriers, was then alluded to; and attention was next called to the principle of compensation for injuries sustained, Lord Campbell's Act being specially cited, as the Parliamentary recognition of that principle. It was said that this act removed a technical difficulty in the way of recovering compensation, rather than gave a new right to compensation. The money payment, thus provided, operated as a punishment, and tended to prevent the commission of careless acts. Compensation might, therefore, be looked upon, partly as a penalty upon the Company for its corporate carelessness, and partly as a remedy to the sufferer for the injury received. If viewed as a remedy, it should be such as to tend to prevent a recurrence of the act for which punishment was awarded. It should, therefore, depend on the degree of blame which attached to the management for the accident, and it should be equally certain and just in its operation. In its aspect as a remedy, it should be easily recoverable by the sufferer. As at present levied, it did not properly fulfil either of these conditions, for reasons which were stated. Assuming that such a maximum amount was fixed upon as would fairly compensate the generality of passengers, according to the class in which they were travelling; and assuming that it were made payable in the case of every accident which occurred, beyond the control of the passengers, without there being any obligation to prove negligence, the author was inclined to think, that the fine would be rendered more certain in its operation, but that as a preventive the effect of the alteration would not be appreciable. The true remedy against railway accidents lay, in the author's opinion, with the railway companies themselves. Improved management would be greatly assisted, by placing at the head of each railway a Director of adequate capacity, responsible to the Board for the management of the concern, who should be required to devote the whole of his time to its interests, and be paid in proportion;—by giving the chief officers of the railway control of, and making them responsible for, the several departments, so that they might be held answerable for the results; and by providing a gradation of responsibility throughout all the employés. Improvements in the machinery, and system of working, might be promoted by the formation of an association amongst railway companies, embracing the objects of the association between the German railway companies, and of the association between manufacturers, near Manchester, for the prevention of boiler explosions. It was doubtful, however, whether such an association could become of any practical utility in this country, unless it assumed the form of an association for the purpose of mutual insurance against accidents, managed by a Board of railway officials, chosen from the associated companies.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, December 10th, 1861. J. P. Joule, LL.D., President, in the Chair.

Mr. Baxendell made the following communication:—

A paragraph, headed "Rain following the Discharge of Ordnance," appeared in a recent number of the *London Review*. In this paragraph some new facts, drawn from the American war, are adduced by Mr. J. C. Lewis, in support of the view that a violent concussion of the air by the discharge of heavy artillery has a tendency to cause a copious precipitation of rain. Now, if we may be allowed to regard this effect as an established fact, it seems to me to be one of some interest in connection with the disputed question, whether, in thunderstorms, a discharge of lightning is the cause or the consequence of the sudden formation of a heavy shower of rain. Almost every day's experience, in this climate at least, shows that the production of rain is not dependent upon sudden discharges of electricity from the clouds; and no evidence has ever been brought forward to prove that a high degree of electrical tension in a cloud has a tendency to prevent the resolution of the cloud into rain. Heavy showers often fall from highly electrified clouds without any visible discharge of electricity taking place. We are, therefore, not entitled to assume that the sudden diminution of the electrical tension of a cloud by a lightning discharge can have any material influence upon the rain-forming processes going on in the cloud. As, however, very heavy showers of rain do almost invariably follow lightning discharges, it seems necessary to seek some other cause to account for them. But if we admit that a violent concussion of the air has a tendency to facilitate the conversion of rain-forming material into actual drops of rain, then we may well suppose that the violent concussions produced by lightning discharges, acting on such enormous and dense masses of rain-forming material as are usually collected in heavy thunder clouds, are amply sufficient to produce these sudden and heavy showers of rain.

I am aware that the effect of a discharge of ordnance is usually supposed to be produced by an upward current of air caused by the heat and the gases evolved during the combustion of the gunpowder; but as an hour's sunshine through an opening in the clouds, especially when the sun is at a considerable altitude, would produce a much greater effect in heating and increasing the bulk of the air, this cannot be received as the true explanation of the mode in which the effect of a discharge of heavy artillery is produced.

Mr. Fairbairn stated that he had been making experiments on the process of cold rolling, as applied to iron. He had tested specimens of cold rolled iron manufactured both by Mr. Lauth and Earl Dudley. In the former case, a black bar from the rolls broke with 26·173 tons per square inch, a similar turned bar with 27·119 tons, and a cold rolled bar of the same iron sustained 39·388 tons. The elongations, which may be considered as the measure of ductility, were ·200 and ·220 per unit of length in the case of the ordinary iron, and ·079 in the cold rolled iron. A plate of cold rolled iron, from Earl Dudley, sustained no less than 51·3 tons per square inch. Endeavours were being made to apply the invention to railway bars.

Mr. Brockbank described the Bessemer process of manufacturing iron and steel, and stated his belief that the variously coloured flames on the surface of newly run steel would afford the means of detecting the presence of metals and other bodies by the new method of spectrum analysis.

A Paper, entitled, "Nouveau Système de Communication Télégraphique, rendant impossible toute collision de trains sur les chemins de fer," by Professor Baulet, of Perpignan, communicated by William Fairbairn, Esq., LL.D., &c., was read by Professor Roscoe.

In this plan an insulated wire placed between the rails, and divided in its middle, affords a connection between the instruments at the stations and others situated in the trains themselves. The details of the arrangement could not by understood without the drawings accompanying the paper.

Mr. Dodwell, the Superintendent of the Magnetic Telegraph, described Mr. Mr. Clark's system, which is now in full operation between London and Rugby, and which, he thought, left little further to be desired.

Ordinary Meeting, December 24th, 1861. J. P. Joule, LL.D., President, in the Chair.

Mr. Brockbank exhibited some samples of steel manufactured by Mr. Bessemer's process. These specimens been bent and twisted cold, and showed a remarkable degree of ductility. He stated that the Bessemer steel was one of the most plastic and manageable of metals—more so even than copper. It could be bent, flanged, or twisted, either hot or cold, without annealing, and over a considerable range to temperature—which is not the case with ordinary steel or copper.

A plate of 18 inches diameter had been forced through a series of dies until it formed a tube 13 feet long and 1¾ inches diameter, without any crack or flaw.

A ring of metal could, at one heat, be hammered into a die to form a locomotive engine chimney top.

In drilling a circular hole into a plate, continuous shavings are formed—whereas, in copper, or Low Moor plates, or any other metal, the shavings break into pieces one-sixteenth of an inch in length.

Thin sheets of the Bessemer soft steel can be bent backwards and forwards and forwards hundreds of times without a fracture, and are almost as flexible as paper.

Mr. Binney stated that many years since he had communicated to the Society a description of some markings on the surface of the Kerridge flags. At that time he could not satisfactorily account for them. He afterwards published, in Vol. X (new series) of the Memoirs, a Paper on similar markings, found in the Upholland flags, near Wigan, and attributed them to the burrowing of an animal similar to the common lug worm of our coast, the *arenicola piscatorum*. Similar holes have since been found by Mr. Salter, F.G.S., in rocks of various ages, from the Cambrian upwards, and that distinguished palæontologist has called them *arenicolites*.

The position of the Kerridge flags is, probably, one of the best ascertained in the whole coal field. It is in the lower division above the millstone grit. In his lower coal field he gives two main beds of flagstones: the first or the lower, the Rochdale series under the rough rock; and the upper, or Upholland or Kerridge series, above the same rock, the chief workable beds of the lower coal field of Rochdale and other districts, often termed the "mountain mines," lying midway between these two flag deposits. This series of coal is now, and has been for many years, wrought under the Kerridge flags, so as to prove beyond doubt the position of the latter. Some discussions have have lately taken place in the newspapers at Macclesfield as to whether the the Kerridge beds were permian or carboniferous. No one, who ever saw permian beds, could ever for one moment suppose Kerridge flags to belong to those strata. It is possible that permian beds may exist in the low district lying between Kerridge and Macclesfield, as they have been met with at Hug Bridge on the south, and Norbury Brook on the north, but up to this time they have not been proved to be there.

Considerable interest has been excited by the discovery of what were supposed to be the foot-marks of some animals on the surface of the flags. He had been induced to make two journies to Kerridge for the purpose of examining them. Once he found two ripple marks pressed into one, which somewhat resembled a human foot, and which was shown to him as the mark of one; and at another time he was shown what was called a track of some animal, but which was evidently no track at all, but most probably made by running water. Although plenty of worm holes and ripple marks are to be found on the surface of the Kerridge flags, as yet he had seen no tracks of animals upon them.

Mr. Edward Hull, B.A., called attention to instances of glacial striations recently discovered by Mr. G. H. Morton, at Liverpool, during a recent visit to that town in connection with his duties on the Geological Survey. Mr. Hull was kindly conducted by Mr. Morton to the spots where the striæ are visible. One of these is at the south, the other at the north side of the town, and at the latter the extent of surface exposed is several hundred square yards. The rock-surfaces had been protected by a thick coating of boulder clay, which had been removed for brick-making. It is owing to the protection thus afforded to the rock that the striations are preserved in all their original freshness. The rock belongs to the New Red Sandstone, and is a moderately hard reddish-brown and yellowish building stone. There are two systems of striæ, the primary one ranging N.N.W., the secondary nearly east and west. Of the latter, the markings are comparatively unimportant, but are very clear and sharp. The primary striæ run in remarkably straight lines—in the form of deep groovings and scratches, and the whole surface of the sandstone is worn down to one uniform gently-sloping plane.

It appeared evident, from the directions of the striæ, that they had been produced by icebergs coming from the north, in all probability from the Cumberland mountains, where glaciers are known to have existed during the period of the boulder clay, or rather earlier. The secondary groovings might have been produced by bergs coming from North Wales, but this appeared very problematical. The interest attached to these cases of glaciation was stated to arise from their position at so great a distance from the Cumberland range. In the immediate neighbourhood of these mountains, as also in that of North Wales, ice-moulded surfaces have frequently been observed, but never before on the New Red Sandstone of Lancashire or Cheshire. (See Mem. Lit. and Phil. Society, Vol. I., 3rd Series.)

Mr. E. W. Binney referred to the existence of similar striations on the Carboniferous Limestone of Great Ormes Head, where the groovings were found to range northward, or outwards from the mountains of the interior. He also noticed the distribution of the Shap granite, blocks of which he had lately seen on the high Salurian and Carboniferous ranges to the south and south-east of Shap Fell.

Mr. Brockbank stated that, on the high lands of Yorkshire and Derbyshire, he had observed erratic blocks which could be traced to their northern sources.

Mr. Hull, in conclusion, stated that it had been abundantly shown, by the collection of a large number of facts, that the direction of the erratic blocks of the drift period was from north to south, so that there must have been some predominating influence in operation—either prevalent winds, or, more probably, oceanic currents—tending to impel southward the icebergs and rafts which were the vehicles for the transportation of the erratic boulders and pebbles.

ON THE INFLUENCE OF THE SEASONS ON THE RATE OF DECREASE OF THE TEMPERATUE OF THE ATMOSPHERE WITH INCREASE OF HEIGHT, IN DIFFERENT LATITUDES OF EUROPE AND ASIA.

By Mr. Baxendell, F.R.A.S.

The determination of the laws of the distribution of heat in the different strata of the atmosphere, under various circumstances of season, locality, direction of the wind, barometric pressure, &c., is one of the most important, and, at the same time, one of the most difficult problems which can engage the attention of the meteorologist. Notwithstanding the labours of many able meteorologists and physicists, several points of considerable importance to the future progress of meteorology are still involved in doubt and obscurity; and the necessity for further enquiries has been so generally acknowledged, that at the late meeting of the British Association in this city, a grant of £200 was renewed to defray the expenses of balloon ascents, to be undertaken for the purpose of obtaining additional data, of a reliable character, to serve as a basis for future investigations. The author, therefore, thought it might be worth while to submit to the Society some results which, although confessedly imperfect, seem to him to indicate very clearly the existence of a law of distribution of temperature in the higher regions of the atmosphere in the different seasons in different latitudes of Europe and Asia, which appears to have hitherto escaped notice, and which seems likely to have an important bearing upon many interesting questions in meteorology.

From numerous observations made at elevated stations in Europe and India, it has been concluded, 1st,—That the general rate of decrease of the temperature of the atmosphere with increase of height, is least in low, and greatest in high latitudes; and 2nd,—That the rate of decrease is greatest in the summer and least in the winter months. Some results, however, which the author obtained in the course of an investigation of the relations which exist between falls of rain and changes in the decrement of temperature on ascending in the atmosphere, and of barometric pressure, in different localities, led him to doubt the general correctness of the second of these conclusions, and he has therefore examined all the observations that were accessible to him which seemed likely to throw any light on the subject; and from the results which he has obtained he shows that there exists in the temperate latitudes of Europe and Asia a belt or zone in which the decrease of temperature, for a given ascent in the atmosphere, is greatest in the winter months, while at stations north or south or this belt, so far at least as observations have yet been made, the decrease is greatest in the summer months.

This belt passes over Portugal, Spain, Sicily, Southern Italy, the Caucasian provinces, and Southern Siberia; and at places lying within it the changes of temperature produced by change of season are greater in the higher than in the lower strata of the atmosphere; while, on the contrary, at places north or south of the belt the changes of temperature are greatest in the lower strata. The details of the results are given in the paper, and all the temperatures are reduced to Fahrenheit's scale, and the differences of elevation to English feet.

The great changes of temperature which take place in the higher strata of the atmosphere in the belt, indicate a less capacity for heat and a greater degree of dryness of the air in these strata than in the corresponding strata beyond the belt. The author was therefore led to conclude that the ratios of the quantities of rain falling on the mountain and on the plain would be less at places in the belt than in other localities; and the results which he has given of the comparisons of the mean annual amounts of rain-fall at different stations fully bear out this conclusion. Comparisons are also made of the falls of rain during the winter and summer halves of the year; and it is shown that at places in the belt the ratio of the quantity falling on the mountain to that falling on the plain is greater in the summer than in the winter half of the year, while, on the contrary, at places beyond the belt, it is greatest in the winter half.

The author then draws attention to some results which appear to indicate that the annual rate of decrease of temperature, on ascending in the atmosphere, is subject to a periodical change. Comparing Geneva and Milan with the Great St. Bernard, the annual rate for the years 1848-58 exhibits, with but trifling irregularities, a gradual increase up to the beginning of the year 1854, and afterwards a gradual decrease. The differences of temperature between the two stations Bywell and Allenheads, in Northumberland, at a difference of elevation of 1273 feet, also show a progressive increase from 4·14° in 1856, to 5·07° in 1860. The author remarks that the epoch when the rate of decrease was at a maximum, as shown by the Geneva and Great St. Bernard observations, corresponds exactly with the epoch of minimum magnetic disturbance, as determined by General Sabine from the magnetical observations made at the colonial observatories and at Pekin; and he shows that there is some probability that the period of the change in the rate of decrease also corresponds with the period of magnetic disturbances.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

April 10th, 1862, Mr. James B. Walton, Vice President in the Chair.

"ON SINGLE AND CONTINUOUS STRAIGHT GIRDERS."

By Mr. Francis Campin, President.

After a few preliminary remarks upon the impulse given to the progress of bridge building by the introduction of wrought iron as a material for that purpose, the author proposed to explain a simple and practical method of proportioning the flanges of straight girders. The amount of strain upon any part of a straight girder, might be calculated to the greatest nicety by formulæ deduced from mathematical investigations, which however are generally too complicated, to be practically available.

The curve of strain upon a girder simply supported at each extremity is a parabolic segment, which, however, may be closely approximated by a circular segment, hence the least area of any section of the flanges may be measured on the ordinates of a curve drawn as follows.

Find the area at the centre of the girder, from which point lay off to scale at right angles to the girder, an ordinate, representing such area, then describe a circle passing through the extremities of the ordinate and line of girder. It is desirable that the vertical scale of areas be as small as possible in proportion to the horizontal scale. The area of either flange at the centre, including loss by rivets, may be found from the expression,

$$0{\cdot}0313\ \frac{w\ l^2}{d}$$

where w = load in tons per foot run, l = space in feet, d = depth in feet, the result being the area in square inches.

One span of a continuous girder may be regarded as virtually divided into two or more parts, a central part acting as a girder supported at each end, and limited in length by the points of contra flexture, which part may be treated exactly as any ordinary single girder as described above, and one or two end parts of which each acts as a girder fixed at one end and free at the other, bearing an uniform load w per foot run distributed over its length, and a concentrated load at its extremity, equal to half the total load on the central part of the girder. The area at the point of fixture being found for either flange from the expressions.

$$\frac{W\ x}{8\ d}$$

where w = total load on half beam and on central part, d = depth of girder, x = distance of point of contraflexure from point of support = length of half beam. All that remains to be determined is the value of x, which corresponds to a minimum area of the curve of strain.

The author then explained the process of finding x, which gives for a beam fixed at both ends

$$0{\cdot}25\ l.$$

And for a beam fixed at one end, and supported at the other.

$$0{\cdot}215\ l.$$

In the case of a continuous girder, the values of the x's are assumed first as equivalent to one of the above quantities, and then reduced to give an equivalent of area over the points of support, whichever span such area is calculated from.

The author then proceeded to find the actual saving from the use of continuous girders, and from a calculation of numerous existent cases found that it sometimes amounted to 25 per cent. of the weight, averaging about 18 per cent.

These results were obtained from an empirical formula, for the weight of metal in a bridge, supposing single spans to be used, it is,

$$\frac{b.l^{2\cdot25}}{10{,}000}$$

giving the weight in tons, b = the breadth, and l = the span both in feet, the quantity 2·25 being found from the expression

$$n = \frac{\log. w - \log. w' + \log b' - \log b}{\log. l - \log. l'}$$

in which, w, b, l, w' b' l' are the weights, breadths and spans for two cases n = 2·25 was the mean result of solutions of the above equations.

THE LONDON ASSOCIATION OF FOREMEN ENGINEERS.

At the last meeting of this association, Mr. John M. Oubridge, of Messrs. Simpson's, Pimlico, read a paper "On Cast-Iron." He regretted, primarily, that pressure of duty had prevented his devoting as much time to the preparation of the paper as its subject demanded. Generally speaking, there were no fixed rules or formulæ laid down for the guidance of those who conducted the processes of founding castings of iron, and foremen of foundries were consequently left much to their own individual ingenuity and talent, in conducting the work entrusted to them.

The density of pig iron frequently varied to the extent of 12lb. in the cubic foot. Its cohesive strength, of course, ranging proportionably. In point of crystallisation, again, what diversity was found! Some iron—for example, made from the black band ores of Scotland—was remarkable for the large size of its crystals. In the process of crystallisation this iron did not require such an amount of supply as the Staffordshire irons. Then, if a comparison were instituted between the black band ore and the red hematite ore as to cohesiveness, it would be found that the first possessed little of that qualification—at all events, until it had been frequently remelted—whilst the hematite possessed it in a remarkable degree, when melted at once from the pig. The fusibility and the fluidity of iron differed, too, exceedingly. The rich black band iron of Scotland retained its fluidity much longer than either the Staffordshire, Welsh or Cleveland irons. Thus, coming to the question of purity, the "Bowling" pig iron was distinguished by its firm, grain; the "Blacknavon" for its freedom of dross; and the "Old Park" for the fine polish of which it was susceptible. In using other kinds of iron it was found that, while in a fluid state, impurities were constantly rising to the surface; and as yet no laws have been laid down for the guidance of the practical founder.

Scientific men, chemical and otherwise, were much at fault in respect to these and other matters connected with cast-iron. The mixtures of various irons for producing castings suitable for the diversified purposes to which they were put were only empirically known. This was a wide field of scientific research, but he (the reader of the paper) for one should be glad to see more scientific labourers employed in that field. He did not claim any especial merit for knowledge of the science of metallurgy, but he regretted that so little had been done by others in that particular branch of that science.

When the serious and disastrous failures of castings in iron were taken into account, surely little enforcement from him was necessary to demonstrate that the making of such castings was not understood. There was a hap-hazard about the process which too often was revealed by the sacrifice of human life. The fatal beam of the Hartley Colliery engine was a case in point. It was an open sand casting of irregular thickness, as regarded its bosses and ribs, and the power of supplying the requirements of crystallisation by heads of pressure, was absent at the time of its formation. Everyone whom he was addressing probably knew that a plate of iron cast in open sand was one-third weaker than when cast covered, and with a sufficient head to give it uniformity. It was strange that the Hartley beam had been cast without this simple precaution having been taken, aed he thought that, for the honour of the founding trades generally, it was desirable to mention the fact. He trusted, rather than thought, however that this was an isolated case.

The principles which should guide the founder in the method of supplying crystallisation seemed to be but little understood. How frequently had he in daily experience to meet this difficulty, and how often was the difficulty not found too great to be surmounted? Some years ago, when in Liverpool, several large rolls for sugar mills were to be produced in the foundry with which he was then connected. Repeated failures in making sound castings occurred, and all the "heads" and all the "feeding" they would give seemed to be of no avail. The want of homogeneity soon became visible in the latter, and half-a-dozen rolls were condemned. Being consulted by the head foreman on the matter, he (Mr. Outridge) suggested that, instead of four heads, one above each arm of the roll, the mould should be made some eighteen inches, and an annular head double the thickness of the roll be furnished. This plan was adopted, and no more failures occurred. The same system he now always applied in casting large cylinder covers, the bosses of engine beams, and other works of a character which demanded homogenity and perfect crystallisation.

What the founder wanted was a special treatise on practical iron founding. Every other branch of manufacture almost had its organ or organs of information, the practical ironfounders had none. Men whose names stood high in the scientific and mechanical world possessed but meagre stores of information in reference to iron founding; and when they ventured to think about it, this fact was made painfully apparent.

A *Manual of Civil Engineering* had lately been produced by Professor Rankine. He wished that some one competent for the task would publish a *Manual of Iron Founding*. Some few of the questions which such a book should resolve he would enumerate. The most improved method of moulding. The different qualities of iron, and how to judge them. The effects of sulphur on iron. Of manganese. Of arsenic. Of sulphate of lime. Of sulphate of copper. Ores, and how to distinguish those best suited for particular purposes. The effects of crystallisation. Of expansion and contraction. The different kinds of coke and its effects upon iron. How to manage a furnance. The methods of smelting iron. And, lastly—though we are only on the threshold of queries—the proportions of different kinds of iron to be used for particular purposes, and why? Mr. Oubridge trusted that his hint for the publication of a manual might be adopted, if the right man or men could be found to compile it.

After the conclusion of Mr. Oubridge's paper, the Secretary said he trusted that at their next meeting a paper would be forthcoming on wrought-iron, especially as applied to the sheathing of ships of war.

BLUNDELL'S IMPROVED REFRIGERATOR.

Mr. Blundell, of Limehouse, has succeeded in perfecting a Refrigerator capable of cooling beer at the rate of fifty barrels per hour; and as we have considered the subject deserving of notice in our pages, we have much pleasure in presenting our readers with the following description and illustrations of the apparatus.

The apparatus is made wholly of copper; the four cylinders (figs. 1, 2, and 3) being fitted with copper tubes, and each cylinder divided into four nests, so that the beer has to pass up and down each cylinder four times. The water enters the first cylinder through the pipe *a*, rises to the top and enters the second cylinder through the pipe *b*, and so on through the pipes *c* and *d*, and leaves the last cylinder at *e*.

The beer enters the first cylinder and the nest of tubes through the pipe *f* (which pipe is in direct communication with the coppers), passes up and down four times and enters the third cylinder through the pipe *g*, and so on through tne other cylinders until it leaves the apparatus through the pipe *j*, which pipe conveys the beer in a perfectly cool state to the fermenting tuns.

To allow of the apparatus being readily examined or cleaned, it is only necessary to remove the cylinder covers *k*.

We understand that Mr. Blundell's Refrigerator has been fitted, and is in successful operation at Messrs. Taylor and Walker's Brewery, and also the City of London Brewery.

FIG. 1.

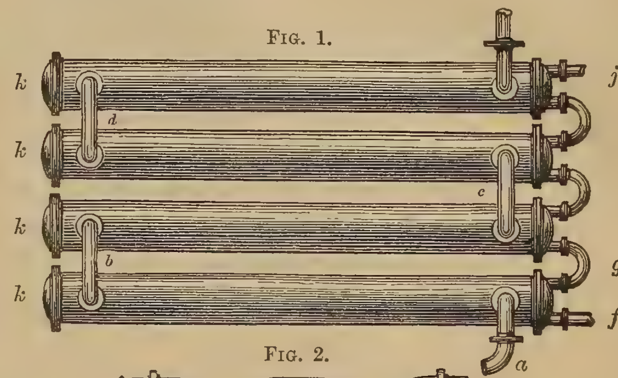


FIG. 2.

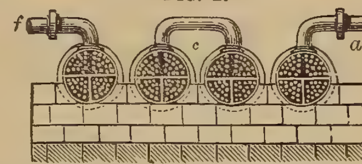
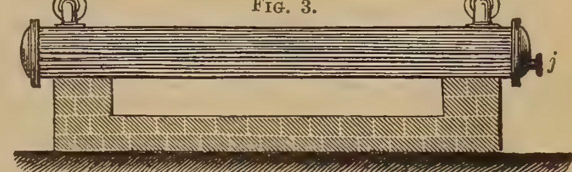


FIG. 3.



TRIAL OF THE "BLACK PRINCE."

The *Black Prince*, iron frigate, fitting for commission at Portsmouth, made her experimental trip outside the Isle of Wight on the 16th ult., to test the capabilities of her enlarged rudder under steam. The original area of the rudder was 130ft.; but with the temporary wooden casing, under which she was tried yesterday, the area was increased to 153ft., giving an increased area of 22·04ft. The draught of water of the ship was, aft 23ft. 1in., and forward 22ft. The propeller is an improved Griffiths's—that is, with the tip of the blades inclining forward, with a pitch of 30ft., a diameter of 24ft. 6in., and an immersion of 2ft. 7in. The *Black Prince* was fortunate in point or weather, the strong N.E. winds and tumbling seas, which had previously prevailed, having subsided into a moderate westerly breeze, with smooth water, so that the trials were made under most favourable circumstances. The first two trials were made to complete a circle at full speed, the time being taken from the giving the order to shift the helm, with 12 men at the wheel, which number of men was continued throughout. The first experiment was "hard a-port," the ship's head being on with the Nab, and the rudder was got over 16 deg. The first half of the circle was completed in 3 min. 52 sec., and the second in 4 min. 13 sec., completing the circle in 8 min. 5 sec.

The second successful experiment was made with the helm hard a-starboard, the rudder being got over 13 deg., and the half-circle being completed in 3 min. 56 sec., the second in 5 min. 53 sec., completing the entire circle in 9 min. 49 sec. The helm was now kept in the same position as in making this last circle, the rudder being at the same angle, and a second circle entered upon, without change in helm or rudder, the time, of course, in this instance being taken with the helm in the required position, and not from the moment of a given order. The half-circle was made, under these circumstances, in 3 min. 32 sec, the second half in 6 min. 6 sec., and the entire circle in 9 min. 38 sec. The next experiment was with putting the helm down hard a-port, and taking the time when the ship's head came on with the object (the Nab) whence the circle commenced. The first half-circle was completed in 3 min. 54 sec., the second in 5 min. 2 sec., and the entire circle completed in 8 min. 56 sec. The next trial was at half-speed, the engines being stopped dead, the ship perfectly stationary, the helm a-starboard, and the time being taken from the engines moving fairly ahead on the word being given. The rudder was got over to 26 deg. before turning a head, but after the engines got into full play this was reduced to 24 deg., owing to the stretching of the tiller-ropes, or some other cause. The ship's head began to

move round a little in this experiment, in answer to her helm, before she actually got way upon her by the action of her engines, a fact that deserves notice. Eight points, or the quarter of the circle, were made in 4 min. 7 sec. Sixteen points, or half the circle, were made in 6 min. 48 sec., and the entire circle was completed in 11 min. 52 sec. The next trial was made under precisely similar circumstances, but with the helm a-port. The rudder on this occasion was got over to 27 deg. and kept to it, an extra turn having been taken round the barrel of the wheel with the ropes, which may have caused the difference in the degrees maintained between this trial and the last. The first eight points, or quarter circle, were made in 4 min. 5 sec; the sixteen points, or half-circle, in 17 min. 16 sec., and the entire circle was completed in 12 min. 20 sec. The revolutions of the engines during this experiment, however, varied from 22 to 34. The temperature of the ship below during the trial was much improved upon that of her trial of speed at light draught on the 19th of November last, on her arrival at Spithead from Greenock. On deck the average temperature was 49 deg. On the engine-room platform the average was 85·03. In the stoke-holes the seven thermometers gave an average, commencing from forward to aft, of 79·6, 96·6, 102·6, 102·0, 91·6, 101·3, and 80·6. At her present draught of water the ship's area of mid-of her screw blades is 66 feet. The mean evolutions of the engines during the trial were—at full speed, 51½; at half-speed, 32. The coal used was the Navigation Steam Coal from the Aberdare pits.
ship section is 1150 feet, with a displacement of 6384 tons. The area of each

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

ON THE FORMATION OF CRYSTALLINE INCRUSTATION OR SCALE IN STEAM BOILERS, AND ITS POSSIBLE PREVENTION WITHOUT CHEMICAL MEANS, OR SURFACE CONDENSATION.

(*To the Editor of* The Artizan.)

The formation of crystalline incrustation or scale in steam boilers is an evil of great magnitude, particularly in the case of ocean steamers, and no efficient remedy for it has been yet made known, probably because the natural phenomena of the process have not been correctly understood.

Of the numerous chemical means which have been proposed for removing or preventing incrustation, none have been hitherto found to stand the test of time in the practical working of boilers, being either ineffective in preventing the formation of scale, or producing some other inconvenience of perhaps equal magnitude with the evil intended to be remedied. Many private testimonials in favour of various chemical compounds for preventing incrustation in boilers are in circulation, but the following remarks of Mr. H. W. Harman, C.E., Chief Inspector of the Manchester Association for the Prevention of Boiler Explosions, in his report for August, 1860, will show that we should be careful in accepting them as proofs of the real practical efficiency of the methods indicated as permanent and convenient remedies for the evil:—"The incrustation in boilers, especially that composed of sulphate of lime, and forming a hard scale on the plates, continues to give considerable trouble and annoyance, and the various attempts that have been made to counteract this deposit have proved unavailing. Doubtless Dr. A. Smith's recommendations, contained in the report distributed to our members, would neutralise it, but the difficulty is in obtaining the necessary antidote in such a commercial shape as shall render it easy of acquirement at a moderate cost, and effective in quality. Several compositions have lately been tried, and from the success obtained in some instances I have been induced to countenance, if not recommend, their adoption in others, but I regret to add without any satisfactory result. Whether this has arisen from the bad quality of the material supplied, or from adverse chemical combinations with the water used, I am unable to determine. But as manufacturers of these compositions are naturally desirous of securing my approval as your representative, I take this opportunity of cautioning our members against any representations of the kind, as although I am fully impressed with the importance of the subject, yet at this moment I do not know of any composition that will remove, or even mitigate the effects of the deposits alluded to. Whenever I can conscientiously do so I shall only be too happy in making this Association the medium of affording such information to its members."

Theoretically, surface condensation presents an efficient remedy, but that this process must be attended with serious practical difficulties is evident from the failure of the attempts of numerous inventors, from Watt and Cartwright to Samuel Hall, whose tubular condensers were introduced into several steam ships about 20 years ago, but were in all instances abandoned after a shorter or longer trial. The theoretical advantages offered by surface condensation are so important that this subject has continued to occupy the attention not only of practical engineers, but also of scientific physicists, among whom may be mentioned Drs. Joule and Professor W. Thomson. Prissen's surface condensers have been used to some extent in American steamers with various results, and several patents have been recently obtained in England for methods of condensing steam without injection, among which may be mentioned the arrangement of Mr. J. F. Spencer as having given satisfactory results during a trial of some duration.

From persevering experiments made under my direction about ten years ago with a surface condenser similar to Hall's arrangement, I found that the principal obstacles to effective and sustained action of the apparatus arose from the deposit on the inside of the tubes of a coating of fatty matter from the cylinder, coloured with metallic particles, and mixed with earthy slime apparently carried over from the boiler by priming, which deposit, after a longer or shorter time, accumulated to such an extent as to prevent the free transmission of heat through the metal. By a more sparing lubrication of the cylinder this evil was mitigated, but it still existed, and by suspending altogether the admission of grease or oil to the cylinder it was found that the rubbing surfaces were subject to uncertain, and, in some cases, rapid wear, particularly when working with comparatively dry steam. The result of the trial was that the use of this condenser was found to be incompatible with regular lubrication, and it was consequently given up. In Spencer's method the steam passes outside of the tubes, and the cold water is caused to circulate through them by means of force pumps; this arrangement seems to lessen the tendency to the formation of fatty deposite in the condenser, and the insertion of the tubes with india rubber packing renders it easy to clean the apparatus by removing and replacing the tubes as occasions may require. In some cases extraordinary phenomena of corrosion have been observed in boilers working in connexion with surface condensers of which no satisfactory explanation has been given. In others the water spaces of the boilers have been found clogged with an unctuous deposit resulting from the fatty matters used to lubricate the cylinders, more or less decomposed and indurated by the action of heat; and altogether it would seem that the method of surface condensation is not yet understood sufficiently in its practical bearings to render its general adoption advisable without further experience.

In this state of things the prevention of incrustation and scale in steam boilers generally, and particularly as regards steam navigation, is a desideratum of great importance. The investigation of the chemical phenomena attending the formation of crystalline incrustation in boilers became a subject of interest to me many years ago, and much speculation with various experiments resulting from direct observation failed to suggest any efficient remedy for the evil, till at length with the aid of analogy I was enabled to imagine a theory of the formation of crystalline "scale" which seemed to explain the principal phenomena, and at the same time indicate a remedy. The object of this paper is to give a succinct explanation of my theory, and to point out the practical applications which it suggests.

The analogy to which I have alluded was offered by the formation of calcareous crystalline incrustation in water pipes. The city of Palermo is copiously supplied with good spring water, conveyed through earthern pipes, from various sources in the elevated grounds in the vicinity, and the old moss-covered water towers form a picturesque feature in the appearance of the suburbs and the neighbouring country. The writings of Ximenes and other Sicilian engineers of the sixteenth century prove that good hydronamical knowledge then existed in this land of classic memories, though unfortunately scientific progress has been but little encouraged here in more recent times. Many of these water towers, or "needles" as they are technically called, seem to have no other purpose than that of affording a free escape to the gases disengaged from the liquid in its passage through the main pipes, as experience had early taught the necessity of such ventilators to insure a regular and uninterrupted current of water. Some of these old water pipes are found to be internally incrusted with calcareous matter of hard crystalline texture, and of such thickness as nearly to close close up the passage through the pipes. It is remarkable that this incrustation is of equal thickness (or nearly so) all round the interior of the pipes, the roof of horizontal passages being as thickly coated with the calcareous crust as the bottom and sides. A four-inch pipe is sometimes found with a central bore of only about 1½in. remaining free for the passage of the water. It is difficult to ascertain the period of time required to produce these effects, which must, of course, be greatly modified by the local circumstances; the amount of incrustation just mentioned is supposed to have required a period of at least a century, probably much longer, in the Palermo water pipes, and the texture of the mass is so compact that it is susceptible of a polish as fine and durable as that of the hardest marble.

It is well-known that spring water generally contains air and carbonic acid gas either in a state of actual solution, or so circumstanced with respect to the liquid medium as to occupy very little perceptible space under common atmospheric pressure. The presence of these gases in the liquid greatly increases its power of dissolving earthy or calcareous substances, and conversely, the liberation and escape of these gases cause a corresponding precipitation of solid matter from the water. Thus the clearest spring water, drawn fresh and sparkling from its source, contains a considerable quantity of calcareous matter which cannot be separated by any mechanical process of filtration, because held in actual solution in the liquid. If the gases are withdrawn from the water by boiling, or agitation in a vacuum, the liquid becomes turbid, and, after a sufficient interval of repose, a fine earthy deposit falls to the bottom.

The circumstances which favour the disengagement of fixed air and gases from water are principally, heat, relief of pressure, and friction, or agitation, each and all of which have their effects promoted and increased by the presence of extraneous solid matter in the liquid, and the contact of rough uneven surfaces of the interior of the containing vessels. Thus the motion of water through pipes or close channels, tends to disengage the gases it may contain, perhaps principally by its friction against the interior surfaces of the channels. We here perceive the source from whence the materials of the incrustation of water pipes are drawn, but we have still to account for the particular mode of structure which they assume as a compact crystalline crust of equal, or nearly equal, thickness all round the interior of the pipes. Once the earthy particles are disengaged and exist in the water in a state of mechanical mixture, we may suppose that they would tend to subside to the bottom in the shape of sediment or fine mud if the liquid is at rest; or when agitated by moving currents, the sediment would be swept along with the stream without leaving permanent traces of its existence. The compact crystalline form which is observed in the incrustation indicates that the solid particles are arrested and fixed by the molecular forces of aggregation in the very act of being thrown out of solution, and at exceedingly small distances from the concrete surfaces on which they become fixed, so as to be within the sphere of the attraction of cohesion with those surfaces, and thus subject to the coercive power under which they become component parts of the forming structure. And as in the case of clear spring water passing through pipes, we find that nearly all the earthy matter thrown out of solution assumes the crystalline form in becoming part of the incrustation, the water remaining clear and limpid, we deduce that nearly all the fixed gas and air which escape from the water are thrown out of combination with the liquid at very minute distances from, or in actual contact with, the interior surfaces of the containing channels, thus showing that the liberation of the gaseous fluids is in some way connected with the friction of the liquid against the sides of the tubes, probably assisted by a kind of conducting action of the numerous small points and salient angles forming the roughness or unevenness of the surfaces.

Following up this train of reasoning we should suppose that any solid particles thrown out of solution in the water at distances which would place them beyond the sphere of the attraction of molecular cohesion with the surfaces of the containing walls or other solid matter, would remain isolated in simple mechanical mixture with the liquid. Such appears to be the fact, as the spring water which issues limpid and still sparkling from the extremity of a long line of pipes, if freely exposed for some time to the air, with frequent agitation, is observed to become turbid from the separation of solid matter, and recovers its clearness as this matter is allowed to settle down as fine sediment. If we take a portion of this water and allow it to become entirely dissipated into the atmosphere by spontaneous evaporation, we shall find that all the solid matter which the liquid contains is deposited as sediment at the bottom of the vessel. In this case we may suppose that as the solid matter has been thrown out of solution at the surface of the liquid, and thus at a distance from concrete surfaces, there should be very little crystalline deposit formed on the walls of the containing vessel. If we take another portion of the same water, rendered bright and limpid by deposition or filtration, and boil it for some time in a perfectly clean vessel, we shall find that, on cooling, it again becomes dim and turbid—evidently because more solid matter has been thrown out of solution and remains mechanically mixed with the water. But if the vessel in which the boiling took place be carefully observed, numerous minute particles of solid matter will be found adhering to the bottom and sides in a crystalline form—in short, an incipient formation of scale has taken place. And this scale is so similar to the crystalline crust deposited by cold water in conduit pipes, that we may consider the two substances to be nearly identical. Hence we should be led to conclude that the circumstances immediately attending the phenomena in both instances should also be similar, though in one case the deposit takes place apparently from the motion of the cold liquid through pipes, and in the other it results from the vaporisation of the water in the act of boiling.

It is evident that a proximate step in the process of formation of crystalline incrustation must be the separation of the solid matter from its liquid solvent, but we perceive that the solid matter thus produced may take various forms, as of mud or slimy sediment remaining free in the water, or of incrustation from the adhering of this sediment in a comparatively loose porous state to the walls of the containing vessel, and its becoming less or more indurated in this position, or finally of hard crystalline crust or "scale." This latter form of the phenomenon is the most conspicuous in water pipes, and, as already observed, offers a striking analogy to the formation of "scale" in boilers. We have remarked that the solvent power of the water is diminished by the escape of the gases it contains as it emerges from subterraneous sources, and that as these gases are liberated from the liquid in contact with, or at very minute distances from the walls of the containing channels, the solid particles thrown out of solution by the escape of aerial particles, and left dry, as we may suppose, at exceedingly small distances from the interior surfaces of the pipes, are caught by the coercive force of the attraction of cohesion with those surfaces, and so become fixed according to the laws of aggregation or crystallization of the substance.

In like manner the escape of pure water in the form of vapour from a mass of boiling liquid must leave the remainder super-charged with solid matter, and the formation of particles of vapour in contact with the heat-transmitting walls of the boiler will cause a corresponding proportion of solid particles to be thrown out of solution, and stranded, as it were, on the contiguous surfaces where they are firmly fixed by the molecular forces of attraction ever in operation within their spheres of activity. This is the formation of "scale" properly so called. A still greater portion of the solid particles is thrown out of solution by the formation of vapour more in the interior of the liquid, and this formation of vapour may be supposed to take place principally in contact with the solid particles already existing suspended in the liquid, which act as conducting points for the development or escape of vapour. Hence the increase of the individual volumes of these grains of earthy matter until they become too large and ponderous to be easily held in mechanical suspension in the boiling liquid, and finally settle down as loose deposit. We imagine that in this process some of these granular masses become attached to the bottom and sides of the boiler under the influence of an attraction of aggregation apparently acting on larger particles of matter at distances very much greater than those at which the molecules unite in the process of compact crystallisation, and the concrete matter which results is of a comparatively loose friable texture. This substance more or less indurated by the baking action of heat from without, is known as incrustation, and should be clearly distinguished from "scale."

It has been long known that the presence in boilers of a quantity of loose extraneous matter presenting a large aggregate extent of surface in numerous detached portions, tends to prevent the formation of scale and of hard incrustation. Thus spent tan, bran, potatoes, &c., are sometimes used in steam boilers, and where a useful result is obtained from these means, it may be chiefly attributed to the power which concrete surfaces of rough, uneven texture, are known to possess in favouring the escape of gas, or of vapour from water in contact with them; under which circumstances the solid matter thrown out of solution is less or more attracted by the contiguous surfaces upon which the mineral particles accumulate, and the formation of sediment and crust on the walls of the containing vessels is diminished in proportion.

From the distinction which was above pointed out between "scale" and "incrustation," it appears evident that the various contrivances which are used in steam boilers under the general name of scale-preventers, are in effect for the most part only preventers of incrustation. The solid particles which are thrown out of solution at distances beyond the sphere of the attraction of cohesion with the heat-transmitting surfaces, remain free in a state of mechanical suspension in the water, and in the act of ebullition are observed to be floated to the surface by the ascending currents generated by the upward course of the vapour. Hence blowing-off from the surface is found useful for getting rid of part of the earthy deposit which would otherwise accumulate in greater quantity in the boiler, and there are sediment-collectors which tend to keep the boiler free from mud by taking in the floating slime or scum from the agitated surface of the boiling water and placing it in a state of comparative rest, thus giving it time to settle down to a low point, from whence it is discharged at intervals. But as the earthy particles once free in mechanical suspension in the liquid can no longer form part of a truly compact crystalline deposit, it would appear that the formation of scale proper is not much affected by the greater or smaller amount of free sediment in the water.

It is well known that the formation of scale becomes more rapid and copious in proportion to the increase of the working pressure of the steam in boilers, and I am not aware that any satisfactory explanation of this circumstance has been given. It may naturally be supposed that the separation of solid matter from the water in boilers is in direct proportion to the amount of vaporization, or the quantity of steam formed, irrespective of its density and pressure, and no doubt such is the case in practice: yet the extraordinarily rapid formation of scale in the high pressure boilers of the gun-boats of the Royal Navy was found a very serious obstacle to their efficient service, and the otherwise advantageous employment of high pressure steam in ocean navigation must be, to some extent, discouraged by this circumstance until an efficient remedy for it may be found. My explanation of the phenomena of the more rapid formation of scale under high pressure is briefly as follows: In proportion as the pressure in the boiler is high, the nascent globules of steam are smaller, and consequently the mineral particles in the act of being thrown out of solution are at proportionately shorter molecular distances from the heat-transmitting surfaces and from each other. Under these circumstances a greater number of solid particles must come within the sphere of attraction of cohesion in a given space for equal amounts of vaporization, and hence the more rapid and copious formation of scale in high pressure boilers.

From the foregoing considerations it may be fairly deduced that an effectual method of preventing compact crystalline deposit or scale, either in water pipes or steam boilers, would be to prevent the liberation of gases or vapour from the water in contact with the walls of the containing vessels. Whether such an arrangement would be practicable or expedient in the case of water pipes is a question on which we need not enter here; but it can be shown that steam of any reasonable working pressure may be copiously produced from water without allowing any of it to form on the heat-transmitting surfaces of the boiler. Perkins generated steam in this manner by keeping his boiler quite full of water at a very high temperature, in some cases almost red heat, so that a small quantity of this highly superheated water liberated from the mass (being replaced by an equal quantity of feed water) at each stroke of the piston, furnished by its self-contained heat, sufficient steam to supply the cylinder. I do not know whether Perkins was aware that scale would not be formed in such a generator, but his arrangement was on the whole so unpractical that it never came into use for general purposes, and therefore the qualities, good or bad, of such boilers could be but very little known. There is no doubt, however, that a boiler may be conveniently constructed so that the heating part of it shall be quite full of water, from which no steam is allowed to escape, the temperature of the water being higher than the working temperature of the steam, and the vaporization taking place in a contiguous chamber from the superheated water injected into it at proper intervals for the supply of the engine. A method of effecting this object will be described in another communication.

Palermo, April, 1862. JOSEPH GILL.

(*To the Editor of* THE ARTIZAN.)

SIR,—I have the honour to communicate you some new trials on a vessel, constructed according to the theory given in THE ARTIZAN, March, 1858, p. 55. There we had found, that the dimensions of a vessel of the *smallest resistance* must be distributed in the following proportion, supposing the breadth = 1.

Length of the forepart = 3
Length of the midship = 2
Length of the afterpart = 2

Whole length = 7

By these dimensions we find by the formula and the tables given in the same number of THE ARTIZAN, the whole resistance of the combined forepart and afterpart of the vessel = 0·238, or nearly one-fourth of the resistance of a parallelopiped of the same length and the same midship-section. It being of the greatest interest to prove the correctness of this calculation by experiments, a model of the vessel, 3 feet long, and also a parallelopiped of the same length and the same breadth were constructed for the comparative trials. The apparatus employed in these experiments was of the same construction as the apparatus of Bossut and Beaufoy; the whole length of the basin, through which the two bodies were drawn, was 96 feet, but the running room of the mean velocity had a length of only 50 feet. The time required by the two bodies for running through this latter room was observed on a centrifugal chronometer with the greatest exactitude by Mr. Fink, Permanent Secretary to the Industrial Association of the Grand Duchy of Hesse, so that the results of the following observations can be fully relied upon.

I. First series of observations made with a moving weight of 21 ounces:

Parallelopiped.	Model of the Vessel.
″	″
1. 36·00	1. 17·50
2. 36·00	2. 17·57
3. 36·00	3. 17·30
4. 36·00	4. 17·50
5. 36·50	5. 17·80
6. 36·00	6. 17·80
Average = 36·08	Average = 17·61

The resistance being in the ratio of the squares of the elapsed time by an uniform varied movement, we have the proportion:

$$(36{\cdot}08)^2 : (17{\cdot}61)^2 :: 1 : 0{\cdot}238.$$

II. Second series with a moving-weight of 37 ounces:

″	″
1. 24·50	1. 12·24
2. 24·25	2. 11·99
3. 24·50	3. 11·99
4. 24·60	4. 11·54
Average = 24·46	Average = 11·94

Consequently $(24{\cdot}46)^2 : (11{\cdot}94)^2 :: 1 : 0{\cdot}238.$

Both series of observations give the resistance of the model = 0·238, perfectly in accordance with the resistance calculated by means of the above mentioned formula. This result seems to be of some practical interest, and I take the liberty to request you, sir, to allow the insertion of this communication in your excellent journal.

I have the honour to be, sir, your very obedient servant,

Dr. ECKHARD.

Darmstadt, April, 1862.

STRENGTH OF SCREW SHAFTS.

To the Editor of The Artizan.

The following may be useful to some of your readers:—

Let L = length of stroke in inches.
D = diameter of cylinder in inches.
g = ratio of gearing.
d = diameter of shafts at smallest parts.

With a pair of engines and steam, as in ordinary marine engines, from 15 to 20lbs. per square inch, the diameter of the screw shaft at smaller parts should not be less than

$$d = 0{\cdot}23^3\sqrt{\frac{L\,D^2}{g}}$$

A screw shaft which broke lately had run for ten years at

$$d = 0{\cdot}223\left(\frac{L\,D^2}{g}\right)^{\frac{1}{3}}$$

but it was turned down for a brass liner to

$$d = 0{\cdot}214\left(\frac{L\,D^2}{g}\right)^{\frac{1}{3}}$$

and it broke at that part after working about 20 days. The fracture showed no flaw in the iron.

OMICRON.

(*To the Editor of* The Artizan.)

Sir,—In the December number of The Artizan, 1861, "Omicron" says the co-efficient of friction of hard wood upon cast iron, as in the teeth of wheels, is 1·9 times the co-efficient for the surfaces of the journals of engine, but does not mention the co-efficients for other cases where teeth rub against teeth.

I should therefore feel obliged if he would through The Artizan, give us the co-efficients for cast iron upon cast iron, cast iron upon wrought iron, cast iron upon brass, wrought iron upon wrought iron, wrought iron upon brass, and brass upon brass. Hoping that "Omicron" will kindly give us the above information required.

Omega.

[In the paper to which Omega refers, the friction of the teeth of wheels is taken from Morin's experiments. The condition of the surfaces of teeth of wheels in motion may be taken as equal to that of "Plane surfaces in motion one upon the other, slightly greasy to the touch." Morin gives 0·15 as the co-efficient of friction for that state of "oak, elm, yoke elm, wild pear, cast-iron, wrought-iron, steel, moving one upon another, or on themselves." The same author also gives for these substances, when greased in the ordinary way, 0·7 to 0·8. In the paper on "Friction," f is taken equal to 0·08 and

$$\frac{0{\cdot}15}{0{\cdot}08} = 1{\cdot}9 \text{ nearly.}$$

Omega will perceive, by referring to these experiments, or to those of Mr. Charles Haswell—as given in The Artizan—that the amount of the friction of smooth surfaces, when separated by a layer of unctuous matter, depends entirely upon the nature of the unguent, and not at all upon the material of the surfaces.]

NOTICES TO CORRESPONDENTS.

J. W. (Alexandria.)—At the departure of the last mail we had only received a portion of the information you require. The *whole* shall be sent you in a few days.

G. L. (Liverpool.)—We will endeavour to give you, in our next issue, the information you desire.

X.—The number of The Artizan to which you refer is the July, 1860, supplementary number.

B.—The idea is an excellent one, but you have been anticipated by Messrs. Turner and Gibson, of the Hammersmith Works, Dublin, who have patented a breech-loading cannon of nearly the same principle of construction as that which you propose.

J. K. (Gothenburg).—Communication to hand, and will be answered through the post.

V. S. (The *Royal William.*)—We, like yourself, are not quite satisfied with the letter which appeared in our last number respecting the *Royal William.* We shall be glad to receive further definite information from you confirmatory of the vessel having been in existence and at work five years before the date given by our Liverpool correspondent. Send us the data, and the subject shall be thoroughly ventilated by us. Possibly there may be some mistake as to the name of the steamer.

D. R. (Dumfries.)—We have you in mind; should anything occur, we will write you by post.

G. H. (Newcastle.)—We wrote you for some further information in connection with the subject of the tracing forwarded. We have not yet received the information for which we asked. Send us this, and we will decide as to the course we shall pursue.

W. C. (Kittybrewster.)—Pardon our tardy acknowledgement of your very interesting communication. We shall be glad to hear from you again reporting further progress. You are working in the right direction.

"Omicron."—Yes, it came in time, and has been inserted as you will perceive. We will write per post on the other points.

"Naval Engineer."—The Stevens Battery.—The particulars to which you refer are contained in the *Memorial to Congress* by Mr. Edwin A. Stevens. Mr. Stevens has circulated this memorial in the form of a printed pamphlet, which is worthy of a perusal. We have anticipated the greater portion of your letter by giving in another portion of the Artizan, detailed particulars of the *Naugatuck.* Mr. Stevens claims also the honour of having experimented under the direction of his father Col. John Stevens, on the effect of shot on inclined iron plates, in 1814, during the war with Great Britain when his father proposed to defend New York by a circular floating battery, having inclined armour.

Oxyhydrogen and Mersey.—Send us your name and address and we will forward you full particulars as to the mode of manufacturing and using the gas, together with its cost.

REVIEWS AND NOTICES OF NEW BOOKS.

We have received the following books, which will be noticed in our next.

The Stevens Battery "Memorial to Congress."

Mr. Stevens' pamphlet, and have given copious extracts from it, in another portion of The Artizan.

Iron Breakwaters and Piers.

By E. B. Webb, M. Inst. C.E., F.G.S., &c., London, Lockwood and Co., Stationers, Hall Court.

Project of a New System of Arithmetic.

Weight, measure, and coins, proposed to be called the final system, with sixteen to the base. By John W. Nystrom, C.E., London, Trubner, and Co., Philadelphia, Lippincott, and Co.

M. DROUOT'S PATENT APPARATUS FOR MAKING BREAD.

Amongst the objects at the International Exhibition the apparatus of M. Drouot for making bread, has attracted great attention, from the numerous visitors to the building. By M. Drouot's invention, the very objectionable process of hand kneading is dispensed with. As we intend upon a future occasion to revert at length to M. Drouot's invention in noticing the various objects contained in the Exhibition,—and when we purpose giving an illustration and description of the apparatus as exhibited. Suffice it for the present to say that the chief characteristic in M. Drouot's apparatus consists in the extreme simplicity and efficiency of its action which approaches as nearly as possible,—(in the kneading operation) to the way in which the dough is manipulated in making bread by manual labour.

The cleanliness ensured by M. Drouot's process, and the great saving in time effected by it, as compared with the old system will no doubt deservedly attract a great amount of attention from the public in general.

We trust soon to hear of the extensive introduction of the apparatus throughout the country.

SETTING OUT RAILWAY CURVES WITH THE THEODOLITE.

Table of Angles to be set off, with the Theodolite, at each successive Chain, commencing at the tangent.

CALCULATED BY MR. G. J. C. DAWSON.

Chains Length.	For Curve of 10 Chains Radius.	Chains Length.	For Curve of 15 Chains Radius.	Chains Length.	For Curve of 20 Chains Radius.	Chains Length.	For Curve of 25 Chains Radius.	Chains Length.	For Curve of 30 Chains Radius.	Chains Length.	For Curve of 35 Chains Radius.
	° ′ ″		° ′ ″		° ′ ″		° ′ ″		° ′ ″		° ′ ″
1	2 51 53	1	1 54 36	1	1 25 56	1	1 8 45	1	0 57 18	1	0 49 7
2	5 43 46	2	3 49 12	2	2 51 53	2	2 17 30	2	1 54 36	2	1 38 13
3	8 35 39	3	5 43 48	3	4 17 49	3	3 26 15	3	2 51 54	3	2 27 20
4	11 27 32	4	7 38 34	4	5 43 46	4	4 35 0	4	3 49 12	4	3 16 26
5	14 19 25	5	9 33 0	5	7 9 42	5	5 43 45	5	4 46 30	5	4 5 33
6	17 11 18	6	11 27 36	6	8 35 39	6	6 52 30	6	5 43 48	6	4 54 40
7	20 3 11	7	13 22 12	7	10 1 35	7	7 61 16	7	6 41 6	7	5 43 46
8	22 55 4	8	15 16 48	8	11 27 32	8	9 10 1	8	7 38 24	8	6 32 52
9	25 46 57	9	17 11 24	9	12 53 28	9	10 18 46	9	8 35 42	9	7 21 59
10	28 38 50	10	19 6 0	10	14 19 25	10	11 27 31	10	9 33 0	10	8 11 5
11	31 30 43	11	21 0 36	11	15 45 21	11	12 36 16	11	10 30 18	11	9 0 11
12	34 22 36	12	22 55 12	12	17 11 18	12	13 45 1	12	11 27 36	12	9 49 20
13	37 14 29	13	24 49 48	13	18 37 14	13	14 53 46	13	12 24 54	13	10 38 26
14	40 6 22	14	26 44 24	14	20 3 11	14	16 2 31	14	13 22 12	14	11 27 32
15	42 58 15	15	28 39 0	15	21 29 7	15	17 11 16	15	14 19 30	15	12 16 38

Chains Length.	For Curve of 40 Chains Radius.	Chains Length.	For Curve of 45 Chains Radius.	Chains Length.	For Curve of 50 Chains Radius.	Chains Length.	For Curve of 60 Chains Radius.	Chains Length.	For Curve of 70 Chains Radius.	Chains Length.	For Curve of 1 Mile Radius.
	° ′ ″		° ′ ″		° ′ ″		° ′ ″		° ′ ″		° ′ ″
1	0 42 58	1	0 38 12	1	0 34 23	1	0 28 39	1	0 24 33	1	0 21 29
2	1 25 57	2	1 16 24	2	1 8 45	2	0 57 18	2	0 49 7	2	0 42 58
3	2 8 55	3	1 54 36	3	1 43 8	3	1 25 57	3	1 13 40	3	1 4 27
4	2 51 53	4	2 32 48	4	2 17 30	4	1 54 36	4	1 38 13	4	1 25 57
5	3 34 51	5	3 11 0	5	2 51 53	5	2 23 15	5	2 2 47	5	1 47 26
6	4 17 60	6	3 49 12	6	3 26 16	6	2 51 54	6	2 27 20	6	2 8 55
7	5 0 48	7	4 27 24	7	4 0 38	7	3 20 33	7	2 51 53	7	2 30 24
8	5 43 46	8	5 5 36	8	4 35 1	8	3 49 12	8	3 16 26	8	2 51 53
9	6 26 44	9	5 43 48	9	5 9 23	9	4 17 51	9	3 40 59	9	3 13 22
10	7 9 43	10	6 22 0	10	5 43 46	10	4 46 30	10	4 5 33	10	3 34 51
11	7 52 41	11	7 0 12	11	6 18 9	11	5 15 9	11	4 30 6	11	3 56 20
12	8 35 39	12	7 38 24	12	6 52 31	12	5 43 48	12	4 54 39	12	4 17 50
13	9 18 37	13	8 16 36	13	7 26 54	13	6 12 27	13	5 19 12	13	4 39 19
14	10 1 36	14	8 54 48	14	8 1 16	14	6 41 6	14	5 43 46	14	5 0 48
15	10 44 34	15	9 33 0	15	8 25 39	15	7 9 45	15	6 8 19	15	5 22 17

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

TELEGRAPH COMPANIES AND THE PUBLIC.—An action was tried on the 7th ult., at the Sheriff's Court, before Mr. Serjeant Wheeler, to recover damages for delay in the delivery of a telegraphic message, sent to Portsmouth at forty minutes past eleven o'clock, but not delivered until nearly two o'clock. Mr. Hart, the plaintiff, said that the distance from the station at Portsmouth was only about one mile. A person who attended from the British and Irish Magnetic Company said that the real defendents were the London District Telegraph Company, whose lines did not proceed further than London, and this message went through no fewer than four companies. He referred the judge to the conditions on the back of the message, to show that the plaintiff had no real claim. His Honour explained to the plaintiff that the only means of ensuring punctuality was by insuring the message. It was urged on the part of the defendants that the messenger could not find the place to deliver the message; and it also appeared that the defendants had sent a cheque for 6*d.*, for an alleged overcharge, which the plaintiff refused as not being a legal tender. His Honour said the plaintiff could have a verdict for 6*d.*, the latter observing that he should not have brought the action had a proper apology been made.

NORTON AND OTHERS *v.* BROOKE.—This was an action brought by the patentee of an ingenious apparatus for stretching cloth, in the process of weaving it in the loom, against the defendant, who had taken out a licence to use the patent, and who refused to to pay under his contract. The case having been opened, after a consultation between the counsel, it was agreed that the plantiff should have a verdict for £250, and that defendant's licence should be renewed for the duration of the patent.

THE QUEEN *v.* TRAIN AND OTHERS.—This was an indictment against the well known Mr. Train and a number of gentlemen, members of the vestry of St. Mary's, Lambeth, for laying down his iron tramways in the roadway leading from Westminster-bridge to Kennington-park, and making it dangerous to the public. At the conclusion of the trial a verdict of guilty was taken against Mr. Train and his foreman, subject to certain points of law reserved, but the verdict was not entered as against the other defendants.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties,' we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts, Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

THE COAL TRADE.—The supply of coal to the metropolis, per railway and canal, for the last three months, ending March 31st, has been 125,486¾ tons, namely, 123,856 tons by railway and 1630¾ tons by canal. Of this quantity the London and North Western have conveyed 55,308 tons; the Great Northern, 44,318 tons; Eastern Counties, 8,845 tons; the Midland, 5912 tons; Great Western, 5823 tons; South Western, 2829 tons; Chatham and Dover, 755 tons; and the London, Tilbury, and Southend, 165 tons. For the three months the entries at the port of London have been 359,154 tons 15 cwt., against 451,210 tons 9 cwt. at the corresponding period of 1861, showing the large decrease in three months of 92,055 tons 15 cwt. The canal traffic has decreased from 4761½ tons, during the same period to 3,359¾ tons in 1862.

VULCANISED PEAT.—It will be recollected that some few years since a very ingenious invention for the utilisation of the slags from blast-furnaces was introduced to the British public by Dr. W. H. Smith, of Philadelphia, and the same gentleman has now patented an equally valuable process for improvements in the preparation, application, and manufacture of peat. He first "vulcanises" the peat, by boiling and roasting it, either alone or in combination with various acids, alkalies, salts, resinous, calcareous, and other mineral substances, by which process he is enabled to alter the colour and properties of peat, increase its density, render it homogeneous, and expedite the drying and hardening thereof. This vulcanised peat he proposes to employ as ordinary fuel coke and kindling fuel; prepared peat coke for sanitary purposes, deodorising pastiles, peat black, peat leather, blacking, water-pipes, tobacco-pipes, or ornamental articles to take the place of wood or papier mache, and a material used for grinding and polishing other substances. In the subsequent treatment of the peat he proceeds according to the purpose to which it is to be applied. By preference he uses the compact lignite-looking peat, of a dense consistency, and containing but little fibre, to the fibrous peat of recent formation; but when the latter is used for any purpose except the cheaper kinds of fuel, it is rendered non-fibrous, homogeneous, and pulpy by being stirred while in the heating pan with a pronged or forked instrument, which gathers in the larger fibres therein for removal, or the vulcanised peat while warm is triturated and pressed through perforated iron plates in the well-known method applied for years to raw peat.

FRENCH ACADEMY OF SCIENCES.—At a late sitting, M. Gaudin read a paper on the boring of Artesian wells of a large diameter. His plan consists in digging a well five metres in diameter, until the subterranean sheet of water is nearly reached, and then in continuing the work with the borer, traversing all the successive sheets of water until it attains to the jurassic limestone. By this means 500,000 cubic metres of water might be obtained in the course of twenty-four hours, at a height of thirty-six metres below the level of the soil, and representing 2500 horse power, at the expense of a million of francs, which would be covered in less than seven months, by fixing the price of water at one centime per cubic metre. M. Laussedat wrote to inform the Academy that he had accidentally had occasion to determine the difference of longitude between the Observatory of Toulouse and the citadel of Montpellier by means of the electric telegraph, and found the result very nearly the same as that obtained by the surveyors of the maps of France, the difference between the two results amounting to little more than two-thirds of a second. He, therefore, suggested that, since longitudes had been successfully determined before by means of the electric telegraph, this method ought to be preferred to the laborious and costly operations of triangulation, except in extraordinary cases; it being now as easy to determine the longitude of a place as its latitude.

FACTORIES AND FACTORY WORKERS.—A return has been made respecting the cotton, woollen, worsted, flax, hemp, jute, hoisery, and silk factories in the United Kingdom, subject to the Factories Acts. It shows a number no less than 6,378, with 36,450,028 spindles, and 490,866 power looms, and motive power equal to 375,294 steam and 29,339 water. 775,534 persons are employed in these factories, 308,273 males and 467,261 females; 69,593 are children under 13, about half boys and half girls. Taking the cotton factories, we find that in 1850 they were returned 1932 in number, with 20,977,017 spindles, 248,627 power looms, and 82,555 motive horse power; but the cotton factories now are 2887 in number, with 30,387,467 spindles, 399,992 power looms, and 294,130 horse power. The people employed in the cotton factories in 1850 were but 333,924; they are now 451,569. The males under 13 have increased in this interval from 9,482 to 22,081; and the females under 13 from 5,511 to 17,707; of the workers above 13, the males have increased from 132,019 to 160,475, and the females from 183,912 to 251,306. So that in the period since 1850, according to returns laid before Parliament then and now, the motive horse power in the cotton factories is described as having increased no less than 256 per cent., which is very much faster than the increase either in raw cotton imported or cotton goods exported; the persons employed increased only 36 per cent.; but the number of those under 13, 163 per cent.

A NEW LIGHT has been exhibited at Manchester, of which Messrs. Trachsel and Clayton are the patentees. The Ozone light is clear and white, and it is said that all colours are seen by it in their true shade. It is produced by passing a current of air through a small box containing a chemical compound. The gas which escapes from the box and gives the light is said to be non-explosive; its cost is about the same as ordinary gas. With a carriage in motion a sufficient current is produced to cause a constant manufacture and supply of the gas. If it is desired to provide a stationary light, a pressure is produced by clockwork and weights. The cost of the apparatus for buildings would be from £12 to £14; and there would be also required an occasional renewal from the inventors of the liquid wherein their secret lies. The illuminating power of this light, as compared with gas, has not yet been ascertained.

APPARATUS FOR MELTING METALS.—In melting metals which cannot conveniently be exposed to the direct action of the fire, it is usual to employ crucibles or refractory post, into which the metal to be melted is placed; this arrangement, however, allows of but a comparatively small quantity of metal being melted at a time, because the weight of metal becomes more than the crucible will bear, if made sufficiently thin to transmit the heat with facility. As an improvement upon the process, Mr. G. F. Muntz, of French Walls, Birmingham, proposes to place the metal in a vessel of brickwork, lined with fire-clay, and through the bottom of this vessel are formed holes or passages, which are covered with tubes similar to inverted crucibles without bottoms, and made in a similar manner of fire-clay, or other refractory material. Under the vessel containing the metal a furnace is formed, and the heat passes up into and is transmitted through the refractory tubes to the metal, the vessel containing which is suitably covered. The refractory tubes may be arranged to pass horizontally, or in an inclined direction, through the metal-containing vessel, but the vertical arrangement is preferred. When the metal is melted in a crucible or pot, the weight tends to burst the sides of the vessel outwards, but when Mr. Muntz's arrangement is employed the metal is exterior to the refractory vessel, and tends to press its sides inwards or crush it, a strain which is much more easily resisted than a tensile or bursting strain. The arrangement has the further advantage that any quantity of metal may be melted together, the melting vessel being made sufficiently large.

A ROCK-BORING MACHINE, invented by Capt. H. N. Penrice (late of the Royal Engineers), is now being worked by Messrs. Hawks, Crawshay, and Sons, in the Claxton Quarry, at Gateshead-upon-Tyne. It cuts a bore 7½ft. in diameter, at the rate of from 8 to 13in. per hour. This is far in excess of what is being done by drilling with compressed air, and by blasting in the Mont Cenis Tunnel, and it is a much less costly operation. Immense power may be applied on the principle of this machine, and a much greater rate of progress than the above may be obtained. It is well worth the inspection of all contractors and mining engineers.

ARMSTRONG'S HYDRAULIC CRANES.—On the 8th ult. the first practical test of Sir William Armstrong's hydraulic cranes was made. A vessel containing thirty tons of iron rods was cleared by this means in about two hours, and the rods carted away. A trial was also made with the hydraulic capstan, which proved eminently successful, as also did the cranes.

STEEL BOILERS.—The Great Western Railway Company of Canada have two of their largest-sized freight engines provided with boilers and fireboxes made of "steel" or "homogeneous" metal, manufactured by Messrs. Cameron and Co., of Sheffield. The engines have been constantly at work for some 15 months, and as far as present experience goes, these boilers are likely to fulfil all that was expected from them. A considerable number of steel fireboxes are in use upon the same line, and have hitherto given every satisfaction.

THE LARGE IRON CAISSON, manufactured by Messrs. Westward, Baillie, and Campbell, Blackwall, for the docks at Sheerness, has arrived at that establishment, at which it is being fitted. By the use of this caisson about 100 feet additional working space is obtained in each dock, thereby enabling line-of-battle ships to be placed in docks which formerly could accommodate nothing beyond a 20-gun ship.

THE NAVAL RESERVE.—Her Majesty has been pleased to confer upon Capt. J. H. Brown, R.N., Registrar-General of Seamen, the honour of Companion of the Bath, as a recognition of the services rendered to the country in originating and carrying into effect the measure for forming a Naval Reserve. The force now numbers nearly 12,000 picked A.B.'s.

VALUABLE SUBSTITUTE FOR METAL.—Adamas as a substitute for metal in the manufacture of gas-burners has frequently been mentioned, and it has also been stated that the same substance was equally applicable to various other purposes for which metal has been employed. The use of the "adamas" burners has recently become very general, and Mr. Leoni, the inventor and manufacturer of them, has now succeeded in introducing adamas taps and adamas machine bearings, the working of which has given the greatest satisfaction to those who have employed them. The mode of manufacture consists in reducing the silicate of magnesia to an impalpable powder, and then moulding it into the desired form, and annealing it, the result being that with the greatest facility the utmost precision may be obtained. When employed for taps, the advantage is that an article is produced upon which neither heat nor acids have any effect, at a merely nominal price, and it is anticipated that at no distant period "adamas" steam-cocks will come into general use, to which purpose the material is undoubtedly well adapted, since upon a trial of a couple of ordinary adamas beer-taps (the price of which will be but 1*s.* or 1*s.* 3*d.* to the retail customer), the one began to leak at a pressure of 65 pounds to the inch, and the other stood upwards of 80 pounds, without being affected. But the purpose to which the material may be considered as more especially applicable is for the manufacture of machine bearings, the test which it has stood in this direction being certainly all that could be desired. A steel spindle was run in an adamas bearing for 100 entire days consecutively, at a speed of about 1500 revolutions per minute, yet neither the spindle nor the bearing show the slightest appearance of wear, and several other experimental tests have proved equally satisfactory. But as a single practical application is preferable to any amount of experimental testing, it may be stated that at the works of Mr. H. Grissell, the well-known engineer, a bearing has been for some time in use, and appears to succeed completely. They use it as a fan bearing as a substitute for a Babbitt's patent white metal bearing, brass having been previously proved to be quite inapplicable, owing to the great friction and resulting heat, and, although the shaft makes nearly 1000 revolutions per minute, it is found that the "adamas" bearing remains quite cool, requires oiling but once a day, and shows no appreciable signs of wear. In the position in question the life of a Babbitt's bearing is five weeks, and it is confidently believed that the "adamas" will last for more than as many months.

NAVAL ENGINEERING.

THE "BULWARK," 91 gun line of battle, 3,716 tons and 1,000 horse-power, now on the stocks at Chatham Dockyard, is to be converted into an armour plated frigate similar to the *Royal Oak*, under construction at that establishment, as soon as the latter vessel is completed. The *Bulwark* has been on the stocks about three years and is about three fourths finished. She will require to have one of her decks cut down, and to be lengthened amidships, and otherwise strengthened to bear the heavy armour plates with which she will be encased.

THE "VICTORIA" AND "DUKE OF WELLINGTON, screw three deckers, at Portsmouth, are decided as the next ships for conversion to shield ships on Captain Coles' principle. The *Duke* was originally laid down as a sailing three decker, and was afterwards altered and adapted to the screw. Her engines are of 700 horse-power, and her burden in tons is 9771. The *Victoria* was laid down as a steamship, and has a much flatter floor amidships than any of the converted three deckers; and has doubtless for this reason much greater stability than they. The *Victoria* is of 4127 tons burden, and is fitted with engines of 1000 horse-power nominal, and attained a speed on her light draught trial in Stokes Bay, of nearly 13½ knots.

THE "ROYAL SOVEREIGN."—On the 4th ult., this fine ship was removed from her moorings and placed alongside the dockyard, Portsmouth, for the purpose of being converted from a 131 screw three-decker, to a 12 gun shield ship, on Captain Cole's plan. The *Royal Sovereign* is of 3759 tons burden, builders measurement, is 240ft. 6in. long between perpendiculars, and has an extreme breadth of 60ft. Her engines by Messrs. Maudslay, Son, and Co., are of 800 horse-power, nominal. On her trial in Stokes Bay, she realized a speed of 12·253 knots, at light draught, with an indicated horse-power of 2795·8, a displacement of 4023 tons, and an area of midship section of 803ft.

"THE ARETHUSA" left Sheerness harbour on the 1st ult., for the last trial of her engines, at the measured mile, off Maplin Sands. The following are the results of the six runs with full power:—The first run 4 minutes, 18 seconds: speed 13·953 knots; pressure of steam, 25; revolutions of engines 66. The second run, 5 minutes, 3 seconds; speed 11·146 knots; pressure of steam 25; revolutions of engines, 66. The third run, 4 minutes, 27 seconds; speed 13·480 knots; pressure of steam 25; revolutions of engines, 70. The fourth run, 5 minutes; speed 12 knots: pressure of steam 25; revolutions of engines 61. The fifth run, 4 minutes, 25 seconds; speed 13·585 knots; pressure of steam 25; revolutions of engines 71. The sixth run, 4 minutes, 36 seconds; speed 13·043 knots; pressure of steam 25; revolutions of engines 72; vacuum 28⅞. The average at half boiler power were as follows;—Speed 10·851 knots; pressure of steam 20 pounds; revolution of engines 60: vacuum 28; depth of water forward 17ft.; ditto aft, 21ft.; Griffith's screw; pitch 20 to 26ft.; present pitch 22ft.

ARMOUR VESSELS OF WAR.—The following is the list of the iron steam-vessels now building for the Admiralty at the several private establishments:—The *Agincourt*, 50; the *Northumberland*, 50; the *Minotaur*, 50; the *Hector*, 32; the *Valiant*, 32; the *Orontes*, 3; and the *Tamar*, 3. In addition to the above there are five armour-plated steamers building at the several Royal dockyards, viz.: the *Royal Oak*, 50; the *Royal Alfred*, 50; the *Prince Consort*, 50; the *Caledonia*, 50; and the *Ocean*, 50.

THE FIRST CUPOLA SHIP.—The tender of Samuda Brothers for the construction of Capt. Cole's cupola vessel having been found to be the lowest, it was accepted by the Admiralty. Messrs. Samuda have bound themselves, under a penalty of £4000 (which will be rigidly enforced in the event of any *laches* on their part), to launch the ship on the 10th Feb. 1863. The price at which the contract—viz., £44 15s. per ton—is taken is regarded as very low. The ship, for which £180,000 has been taken in the estimates, is to be 280 feet long, nearly 2600 tons, will draw about 20ft. and will have engines of 500-horse power. She will, according to present arrangements, have six cupolas, each armed with two-100 pounder Armstrong guns.

THE TRIBUNE, 23, screw frigate, tested her speed at full and half boiler power, at the measured mile in Stokes Bay, on the 14th ult. The vessel drew 17ft. 3in. forward, and 20ft. 3in. aft. The wind was at West North West, with a force of two, and comparatively smooth water. The mean pressure of steam in boiler was 20lbs., with 20 pound load on the safety valve, and a vacuum in the condensers of 23½ins. The revolutions of the engines were, at sull boiler power, 69½, and at half boiler power, 26½. Six runs were made at the mile with full power, which gave a mean speed to the ship of 9·665 knots; at half boiler power four runs were made which gave a mean speed of 7·581 knots.

THE PROW OF THE ACHILLES.—The remaining portion of the large projecting iron stem or prow of the *Achilles*, 50, iron vessel, building at Chatbam, has been successfully fixed in its place. The stem is of great strength, weighing upwards of 20 tons, and was forged at the Thames Ironworks, Blackwall. It is made to project some distance from the vessel, especially below the water line, and when used as a ram in running down any hostile ship the *Achilles* will strike her antagonist below the water, by which it is believed that the greatest and speediest amount of injury will be inflicted.

THE NEW AMERICAN STEAM GUNBOAT "NAUGATUCK."—The steam gunboat *Naugatuck*, which has been fitted up and presented to the government by Mr. E. A. Stevens, is finished. The *Naugatuck*, about which so much has been said and written, and from which so much is expected, is an iron screw steamer, constructed in the usual way, all being secured with beams and angle bars of the best material. The lines of the hull are not unusually sharp, as is the case with the famed Stevens battery, but present very much the appearance of one of our old-fashioned Sound propellers. She is not, as is gengerally supposed, intended to be a model of the Stevens battery, but it is merely designed to illustrate some of the novel ideas connected with that monster engine of war—namely, the ability to sink and raise a vessel with great rapidity; to steer and manage her by means of two propellers placed at each side of the rudder, and taking up the recoil of the gun by means of indiarubber. Experiments already made have proved the successful attainment of these points to her constructors, but yet remain unsatisfactory on the mind of the public. The hull of the vessel is constructed of iron, 101 feet in length, 20 feet beam, and seven feet depth of hold. She draws five and a half feet light and nine feet when submerged, and her speed, it is calculated, will be 11 miles per hour when light, and five and a half when submerged. The principal features for her protection from shot and shell are, first, the setting of the vessel two feet lower in the water when going into action, by means of water-tight compartments, two feet deep, between the main deck and outer covering, so arranged as to be rapidly filled or emptied by powerful steam pumps. This does away with the necessity of carrying the weight of two feet of iron armour; while it substitutes to the greatest possible extent, the best known armour—water; for experience has taught that when a ball strikes water it takes an upward direction, and will therefore prove perfectly harmless; and, in this instance, should a ball pass through the deck, it must pass through the bulwarks, unseen and unheard by those between decks. This peculiar arrangement will also give greater speed to the vessel while cruising, chasing, or retreating, inasmuch as it will be able to throw overboard the weight of the two feet of water between deck, and for the same reason to pass over bars and into harbours which she could not otherwise reach. Second, the use of an iron-clad bow, curved inwards, and plated with two layers of half-inch plates, strongly rivetted and bolted, presents the appearance of a ram, which, no doubt, could be effectively used for running down wooden vessels. The curving on the bow is so admirably arranged that only by the merest chance would a ball strike any spot at right angles, and so must glance off; and when submerged she presents but a small surface upon which the enemy can bring their cannon to bear. Her sides above water-line are made of white cedar, fully one foot thick, which is so soft in its nature as to allow a ball to pass through without splintering. The machinery, which is situated abaft midship, consists of two horizontal high-pressure engines, 14-inch cylinder, and 24-inch stroke, working independent of each other, and driving the two propellers at either side of the rudder; an ordinary locomotive boiler, two double oscillating donkey engines, driving two of Andrews' pumps, capable of throwing out 900 gallons of water per minute. The ability of this vessel to round rapidly on her own centre, without making headway, by means of the two screws, instead of the ordinary means employed in making the circuit of a vessel, gives her remarkable and important facilities for manœuvring in action. In connection with her speed, it will enable her to overhaul one after another of the enemy; run close alongside; present herself for action in the most effective position; bring her big gun to bear in any direction; turn in narrow channels, and, if necessary, retreat in any direction with facility. The two screws form two distinct means of propulsion—that of driving the vessel and enabling her to be steered in case of accident to the rudder, which is double the ordinary security against the breaking of machinery in action or otherwise. The armament consists of one 100-pounder rifled gun and two of James's 12-pounder howitzers. The heavy gun is mounted amidships, pointed towards the bow, and is loaded from below by depressing the muzzle downwards, which is effected by means of pulleys ingeniously constructed for this purpose. This gun is loaded by means of a moveable charger, which can be raised or lowered at pleasure. The ramming is accomplished by a sort of piston-rod, elevated on a line with the muzzle of the gun, which is also worked by pulleys, thus affording the celerity of loading and firing every half minute. This gun rests on a shot-proof iron carriage, of which the recoil (only six inches) is taken up by the employment of large indiarubber springs. The hull is divided into four water-tight compartments, and on descending the gangway of either of these compartments you find yourself upon the second deck, in a small iron box, yet having ample accommodation for the purposes for which they have been assigned. The cook's galley is situated at the bow; next come the sailors' apartments, then the magazine and rendezvous for action; and next to this the engine-room, which is abaft midship. The officers' quarters are on deck, comfortable looking, but rather limited. When in action but one person is necessarily exposed.

STEAM SHIPPING.

THE "PRINCE CONSORT," built and engined by Messrs. Caird and Co., for the Loch Lomond traffic, has had a very successful trial of her machinery. The engines worked remarkably smoothly, and with a pressure of 25 pounds of steam she accomplished the satisfactory speed of 16½ statute miles per hour. She was very steady, and, although there was a smart breeze, did not careen in the slightest degree.

THE "COLLEEN BAWN" was launched on the 3rd ult., from the building yard of Messrs. Randolph, Elder and Co., of Govan. This vessel, which has been contracted for by the Drogheda Steam Packet Company, is intended to ply between that port and Liverpool. The following are her dimensions:—Length between perpendiculars, 220ft.; depth in midships, top of keel, 16ft. 7in.; tonnage, 900. The engines, which are constructed after the patent of Messrs. Randolph, Elder and Co., are double cylinder, of 400 nominal horse-power, with feathering paddle wheels. The cylinders are two of 88in., and two of 44in. in diameter, with 5ft. stroke, and completely jacketed on top, bottom, and sides. The steam is cut off at half stroke in the one cylinder, and expanded four times more in the second, making an expansion of eight volumes. The boilers are of the ordinary tubular construction, and carry the usual pressure.

THE "EMERALD ISLE," paddle steamer, built for the Dundalk Steam Packet Company, was lately launched from the yard of Messrs. J. and G. Thompson, of Govan. The *Emerald Isle* is of 900 tons burthen, and 300 horse-power, and she is 240ft. in length, by 28ft. beam, and 16ft. depth. The engines are on the oscillating principle, with surface condensers, feathering paddles, &c.

THE "LEE MIN," screw steamer, intended for the China trade, has been launched by Mr. Thomas Leath, of Rutherglen. This is the third steamer built for the same company and trade, within the last 12 months. The *Lee Min* is 150ft. long, 21ft. beam, and 12ft. deep, and is to be propelled by a pair of direct-acting engines of 60 horse-power, which are expected to give a speed of not less than 10 knots per hour.

THE "RONA," built by Messrs. W. Denny and Bros., has made a satisfactory trial trip, having "run the lights," a distance of 13⅝ knots, one way in 65½ minutes, and back in 63 minutes. The following are her dimensions:—Length, 230ft.; beam, 33ft.; depth to spar deck, 21ft. 6in.; burthen, 1220 tons, old measurement. At the trial trip her draught of water was 7ft. 6in. She has a pair of diagonal engines, the diameter of the cylinders being 46 inches, the stroke of the piston 9ft., and the working pressure 35lbs.

THE "SCOTIA," Cunard steamship, has made her official trip. She was loaded to the average load line, and performed the distance between the Bell Buoy and the North-west Lightship, at the rate of 15 knots, or upwards of 17 statute miles per hour.

NAVAL APPOINTMENTS.—The following naval appointments have taken place since our last:—A. Bain, Chief Engineer, additional, to the *Asia*, for gunboats at Haslar; W. N. Carey, Chief Engineer, additional, to the *Asia*, for the *Duke of Wellington*; C. A. Dwyer, Chief Engineer, additional, to the *Cumberland*, for the *Orion*; R. L. Owen, Second-class Assist. Engineer to the *Termagant*; B. Carr, First-class Assist. Engineer, and G. Bartlett, Second-class Assist. Engineer, to the *Magicienne*; T. F. Hight, supernumerary in the *Fisgard*, confirmed as First-class Assist. Engineer; R. J. Wemyss, Acting Chief Engineer, to the *Indus*, as supernumerary; J. Gillies and R. J. Hay, supernumeraries, in the *Asia*, promoted to Chief Engineers; A. Leitch, confirmed as Second-class Assist. Engineer, in the *Impérieuse*; E. Sappin, R. Roots, W. W. Watts, and W. H. Phillips, Acting Second-class Assist. Engineers, supernumeraries in the *Asia*, to the *Impérieuse*, as supernumeraries; W. Fraser, J. Taylor, A. Hutchinson, and R. Jarvis, supernumeraries in the *Cumberland*, to the *Impérieuse* as supernumeraries; W. H. Kent, J. Slack, D. Crichton, and J. G. Johnson, supernumeraries in the *Fisgard*, to the *Impérieuse*, as supernumeraries; F. W. Brown, Chief Engineer, to the *Tribune*, *vice* Barber, superseded from ill health; H. Williams confirmed as Chief Engineer; P. Butler, Engineer, to the *Fisgard*, for the *Columbine*; G. F. Bell, Engineer, T. Baldwin, First-class Assist. Engineer, and J. H. Bray and F. Hallett, Acting Second-class Assist. Engineers, to the *Zebra*; S. F. Hight, First-class Assist. Engineer, to the *Cumberland*, for the *Herring*; H. Birch, First-class Assist. Engineer, to the *Indus*, for the *Shamrock*; E. Eckersley, First-class Assist. Engineer, to the *Hawk*, for the *Lark*; W. C. Batty, Acting First-class Assist. Engineer, to the *Cumberland*, for the *Spanker*; J. McMillan, Acting Second-class Assist. Engineer to the *Cumberland*, for the *Resistance*; C. J. Serjeant, promoted to Chief Engineer; R. J. Roberts, Engineer, to the *Fisgard*, for the *Dromedary*; J. D. Lamont, First-class Assist. Engineer, to the *Asia*, for hospital treatment; H. Johnson, First-class Assist. Engineer, to the *Revenge*; J. Durwodie, in the *Neptune*, confirmed as Second-class Assist. Engineer; W. F. Cole, Acting Second-class Assist. Engineer, to the *Indus*, for the *Gibraltar*; G. Deans, Acting Engineer, E. D. Dooby, G. Simpson, Acting First-class Assist. Engineers, and E. Williams, Acting Second-class Assist. Engineer, to the *Coquette*; J. Dreardon, First-class Assist. Engineer, to the *Asia*, for the *Pheasant*; G. Jullivan, confirmed as Second-class Assist. Engineer, in the *Greyhound*; J. Dalton, in the *Aboukir*, G. Watson, in the *Edinburgh*, for the *Erne*; A. Lloyd, in the *Pearl*; H. H. Motherson, in the *Impérieuse*; J. G. Hill, in the *Russell*, for the *Hind*; and W. C. Beak, in the *Sphinx*, promoted to the rank of Engineers; J. Blight, in the *Ringdove*; E. Agnen, in the *Revenge*, and S. S. Nunn, in the *Miranda*, promoted to Acting Engineers; W. H. Phillips, W. W. Watts, and E. Topping, of the *Impérieuse*, confirmed as Second-class Assist. Engineers; H. Birch, First-class Assist. Engineer, and J. Cameron, Second-class Assist. Engineer, to the *Fisgard*, for the *Shamrock*; T. Scott, Second-class Assist. Engineer, of the *Alecto*, promoted to Acting First-class; N. F. Hockerston, confirmed as Second-class Assist. Engineer; G. Simpson, of the *Coquette*, confirmed First-class Assist. Engineer; A. Young, promoted to First-class Assist. Engineer; W. Fraser, of the *Impérieuse*, T. W. Dearden, of the *Cumberland*, and J. W. Owen, of the *Dasher*, confirmed as Second-class Assist. Engineers; J. Simpson, First-class Assist. Engineer, to the *Royal Adelaide*, for the *Princess Royal*; J. B. Jillard, Chief Engineer, to the *Adventure*; T. Segar, Engineer, to the *Adventure*; T. Summers, Engineer qualified for charge, to the *Asia*, for the *Psyche*; J. Lawson, Engineer qualified for charge, to the *Fisgard*, for the *Vivid*; J. Fox, Acting Engineer, to the *Asia*, for hospital treatment; H. F. Saunders, supernumerary in the *Indus*, promoted to Acting Engineer; T. Jeans, First-class Assist. Engineer, to the *Tribune*; H. J. Bailiffe, First-class Assist. Engineer, to the *Asia*, for the *Swinger*; J. Jolly, First-class Assist. Engineer, to the *Adventure*; M. M'Intyre, Second-class Assist. Engineer, to the *Adventure*; W. Williams, confirmed as Second-class Assist. Engineer in the *Defence*; J. W. Sivewright, Acting Second-class Assist. Engineer, to the *Adventure*;

R. Pattison, Acting Second-class Assist. Engineer, to the *Asia*, for the *Wallace*; H. W. Ross, Acting Second-class Assist. Engineer, to the *Cumberland*, for the *Adder*; J. Watts, Acting Second-class Assist. Engineer, to the *Cumberland*, as supernumerary; J. W. Nelson, Acting Second-class Assist. Engineer, to the *Indus*, as supernumerary; B. Taylor, Acting Second-class Assist. Engineer, to the *Rhadamanthus*, as supernumerary; J. Glaysher, Acting Second-class Assist. Engineer, to the *Cumberland*, as supernumerary; and E. Gravestock, Acting Second-class Assist. Engineer, to the *Asia*, for the *Traveller*.

RAILWAYS.

RAILWAY ROLLING STOCK.—The extraordinary profits which have been realised by the several railway waggon companies at present in existence, and the high position which this kind of stock invariably maintains in the market, has led to the formation of another similar undertaking—the Metropolitan Railway Carriage and Waggon Company, upon the limited liability principle, and with a capital of £100,000, in shares of £10 each, for the letting of carriages and waggons to railway companies, mineral owners, merchants, and others, such carriages and waggons being built or maintained by the company or by contract, as may appear most desirable. The Midland Waggon Company pay regular dividends of 10 per cent. per annum, and occasionally large bonuses in addition, yet at the present time they have a reserve fund of nearly £60,000; and so high is the estimate which the public forms of its prosperity that the shares average worth in the market twice the amount which the shareholders have paid upon them. The Railway Rolling Stock Association pay 9 per cent. dividend, and have a reserve of over £20,000. The Birmingham Waggon Company pay 10 per cent., and have over £10,000 reserve. And the Gloucester Waggon Company, which builds and maintains its own stock, has paid in its first year's working 10 per cent.. and carried £3500 to a reserve fund. The value in the market of the stock of each of these companies is from 35 to 45 per cent. premium. In the list of directors we notice the names of several gentlemen largely connected with railway property, and who would, no doubt, have considerable influence in promoting the interests of the company.

THE EXPRESS TRAIN from Manchester to London has been provided with appliances for securing a constant supply of gas throughout the passengers carriages, guards van, &c.

RAILWAY ACCIDENTS.

RAILWAY ACCIDENT.—An accident happened to the express train from Milford to London on the 19th ult. The train leaves Milford at 8.15, arrives at Chepstow at 1.46, and does not stop again until it reaches Grange Court Junction, where the South Wales and Hereford and Gloucester lines merge, and which station it reaches at 2.15. Shortly before arriving at Lydney, about two o'clock, and when travelling at a speed of fifty miles an hour, the engine got off the rails. The coupling chains were broken by the violence of the shock, and the engine ran along the permanent way for about 100 yards, and then turned almost completely upside down on the up-side of the line, the tender turning over also and partly resting on the engine. The driver and stoker were underneath the engine and tender, and were afterwards rescued, though both badily injured. The train consisted of three carriages, a second-class at each end and a first-class between. The two first of the carriages broke away in the opposite direction to that taken by the engine, the first of them crossing the down line and striking with great violence against the corner of the goods shed at Lydney station; so violent, was the collision that the side of the carriage was smashed in, and one of the passengers in the first compartment was thrown upon the line and killed. Several of the other passengers were more or less bruised. The first class carriage also got off the line, but none of the passengers were hurt. The third carriage kept on the line, and ran past the other carriages and engine before it came to a stand.

NARROW ESCAPE OF AN EXPRESS TRAIN.—On the 16th ult., the express-train which left Cheltenham at 2·25 p.m., for London, just arrived at the high embankment at Badgworth, about five miles from Cheltenham, when the axle of the leading wheels snapped in the centre, and dropped between the rails, the engine at the same time pitching forward. Tne breaks being applied, the train was brought to a stand before the engine had left the rails. Had the engine once left the rails great loss of life must have ensued, as the Badgworth embankment is of unusual height.

MILITARY ENGINEERING.

IMPORTANT EXPERIMENTS AT SHOEBURYNESS.—On the 8th ult. experiments were made at Shoeburyness against a target of the same materials and strength as the *Warrior's* broadside. The gun used on this occasion was a 300-pounder, manufactured by Sir William Armstrong, on his own principle of wrought-iron coils. The gun is about 14ft. in length, its weight is 12 tons, and its diameter at the muzzle 10½in. It has not been rifled, and therefore during the experiments it only threw round solid shot of 156lb. weight. If rifled for the Armstrong shot, which is about two and a half times the length of its diameter, it would be a 300-pounder. This gun, unrifled and with plain solid shot was tried against the redoubtable *Warrior* target. The greatest interest was concentrated on the effect of the first shot. With the high speed which our *Warriors* are known to possess, and therefore the quickness with which they can steam past batteries or iron ships, it was next to impossible in a running fight that they could be hit twice in the same place. If the target kept out one shot, there was every hope of a ship keeping out all. The first shot, a 156-pounder, was fired with a charge of 40lb. of powder, at a distance of 200 yards. This solved all doubts. With an indescribable crash the shot struck upon a comparatively uninjured plate, shattering the iron mass before it into little crumbs of metal, splintering the teak into fibres, and, though not passing quite through the side, yet bulging and rending the inner skin of the ship in a way that would have rendered it almost impossible to stop the leakage. The second shot (still with a 40lb. charge) struck close by the side of the first, making the previous damage worse. To those who did not actually see the experiments it would be difficult to describe the manner in which the iron opposite the missile was broken into minute fragments like glass; how the teak was so utterly disintegrated that it more resembled tangles of fine twine than even the remains of woodwork; and how, above all, the inner iron skin was ripped into gaps like torn paper. These two shots were quite conclusive as to the power of the gun. Still, however, the shot had not gone completely through the side, which it was the great object of the experiments to accomplish. The charge of powder was, therefore, increased from 40lb. to 50lb., and the gun levelled at the uppermost plate of the target, which had been left untouched in previous tests. On this plate a white spot was painted to guide the artillerymen, and so true was their aim,—so exactly was the centre of the mark struck,—that every vestige of the paint was obliterated. With this increased charge the shot passed, not only through armour plate, teak, and inner skin, but buried itself in the massive timbers that support the target, and even loosened the blocks of granite by which the whole is backed up. Another white mark was then made on the lowest plate of the target, and again the artillerymen hit it with the same precision and with the same result. The shot went through everything. After such decisive results, no further experiments were tried, as the 156-pounder at the last discharge recoiled so much as to get off its wooden platform and imbed the hind wheels of its carriage in the stiff yet watery clay, for the production of which in the largest quantities at the shortest notice Shoeburyness stands unrivalled. But enough had been accomplished, and Admiralty officials and armour shipbuilders could only admit that artillery had at last proved too much for them, and that if invulnerable ships were to be constructed they must begin *de novo*. It was clear to all that the *Warrior* would not stand much chance against the new gun, even unrifled. At the conclusion of these trials some experiments were made against Mr. Fairbairn's iron target, which failed on the last occasion. Since then the armour plates have been bedded on hemp and indiarubber, and the effect of this soft medium in diminishing the force of the concussion upon the iron ribs beyond the plates enabled it to stand much better. But the general feeling seemed to be that some kind of timber backing to the plates was indispensable. The most interesting portion of this experiment was when the Armstrong 200-pounder was fired with a 10lb. charge. Beyond dinting them these missiles produced very little effect upon the plates.

TELEGRAPHIC ENGINEERING.

THE CAPE OF GOOD HOPE TELEGRAPH COMPANY has been brought forward. In this case the capital is fixed at £62,000, in shares of £5 each. A subsidy of £1500 per annum was granted for fifteen years by Act of the Colonial Legislature, in 1861, for the transmission of Government despatches, and it is arranged that interest at the rate of six per cent. per annum shall be paid by the contractor upon the amount subscribed in respect of shares during the formation of the works. The idea is to construct and work electric telegraphs in South Africa, and the line will commence at Cape Town and pass through Caledon, Swellendam, Riversdale, Mossel Bay, George, Uitenhage, and Port Elizabeth, to Graham's Town, a distance of about 610 miles, uniting Port Elizabeth and Graham's Town, the military head-quarters, with Cape Town, the seat of Government and the port of arrival and departure of the mails for Europe.

TELEGRAPH TO INDIA COMPANY.—Advices from Suez state that in addition to the success of the Company in securing communication with the Jubal, an arrangement has been effected with the Egyptian Government, through the influence of Mr. Latimer Clark, who has the work in charge, whereby the Government of Egypt undertake to give up to the Telegraph to India Company, not only the revenue proper derived from their sea line, but also the receipts of the land line between Alexandria and Suez. These latter recipts, even during the first week of opening, were at the rate of £2,000 per annum. It is thought that the chance of repairing the Aden and Kurrachee length, which are being proceeded with, are very promising if the season of good weather continues to its full length, though the time intervening between the present and the end of the usual term of that season is considered much shorter than is desirable, with a view to the devotion of great care to the work.

THE NEW SUBMARINE CABLE.—The Electric and International Telegraph Company's new submarine cable, for connecting England with the South of Ireland, has been successfully laid between the coasts of Pembroke and Wexford, in perfect working order. The caqle munuractured by Glass, Elliott, and Co., is 63 miles in length, contains four conducting wires, insulated with gutta-percha and other materials on the latest improved methods, and is protectected by 12 heavy iron strands, the total weight being 6½ tons per mile. The entire cable is coated with a composition (Bright and Clark's patent) for the purpose of protecting the iron from corrosion and decay.

WATER SUPPLY.

HULL WATERWORKS.—The new Cornish pumping engine, which has been erected at Stoneperry Waterworks, to supply Hull with water, has been started. The engine is of 220 horse-power, has cost £8500, and is from the works of Messrs. Hawks, Crawshay, and Sons, of Gateshead-upon-Tyne. The diameter of the cylinder is 85ins.; length of stroke of piston, 10ft. 6in.; diameter of plunger, 34⅝ in.; length of stroke 10ft. 6in. The pump will deliver at each stroke 427 gallons of water; and as the engine can be worked at the rate of ten strokes per minute, 3,074,400 gallons can be supplied to the town per twelve hours.

GAS SUPPLY.

GYE'S GASOMETERS AND TANKS.—Mr. Frederick Gye, of the Royal Italian Opera, Covent Garden, has invented certain improvements in constructing gasometers and gasometer tanks. He constructs a gasometer tank in such a manner as to render available much of the central space of land now covered or occupied by the tank of a gasometer. The tank is made double at the outer circumference to receive the water or fluid employed, the interior space being left free for use when roofed or closed in air and gas tight. Instead of placing a gasholder tank on the surface or below the surface of the ground, Mr. Gye erects a circular wall of brickwork or a circular framework of iron or other suitable material. This circular erection may be perforated with arched or other openings of a height convenient to admit men or materials being carried through them. The breadth of this wall or erection is to be sufficient to admit of a double or ring gasholder tank being placed on its upper surface; the tank being of sufficient width to admit of the working therein or a single or double, that is, a telescope gasholder. The space extending from one side of the interior tank to the other is to be roofed over. There is then a covered circular apartment approached by the openings through the circular wall or structure below. The roof of this apartment may, if necessary, be conveniently supported by a central column with radiating struts (umbrella like) or by a series of columns or otherwise. This invention is also applicable when constructing gasometers the tanks of which are built below the level of the surrounding ground, and for which an excavation has been made; only, in that case, it would be necessary to descend by an inclined plane, or other means, in order to enter the inclosed covered space under the gasometers. As the action of the wind might be found inconvenient, the outer ring of the tank may be made of a height equal, or nearly so, to the greatest height to which the outer gasholder will rise when completely filled with gas; and on the inside surface of this outer ring are placed either the wheels or the guide-rods necessary to the steady working of the holder.

SINGAPORE GAS COMPANY.—A prospectus has been issued of this company, with a capital of £100,000 in shares of £5 each. Singapore contains about 5,500 houses exclusive of public buildings, and land for the works has been conditionally granted by the governor, while the municipality are prepared to arrange a contract for lighting the streets, &c., for a term of years, The calculation of profit are based on the assumption that coal must be obtained from England; but the belief is that much cheaper supplies will soon be procurable from the Labuan mines or from those of Indian or Australia.

THE BOMBAY GAS COMPANY is projected, with a capital of £250,000, having obtained the concession of the exclusive privilege of supplying Bombay with gas for twenty-one years, and a suitable site for the erection of the works; and the Government have expressed their readiness to use the gas for lighting the public offices.

BOILER EXPLOSIONS.

THE ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.—At the last ordinary monthly meeting of the executive committee of this Association, held at the offices, 41 Corporation-street, Manchester, on Tuesday, March 25th, 1862, Mr. L. E. Fletcher, chief engineer, presented his monthly report, of which the following is an abstract:—"During the last month there have been examined 383 engines, 2 specially; 514 boilers, 10 specially, 8 internally, 51 thoroughly, and 445 externally, in which the following defects have been found:—Fracture 11 (4 dangerous); corrosion 28 (1 dangerous); safety valves out of order, 8; water gauges ditto, 15; pressure gauges ditto, 13; feed apparatus ditto, 2; blow-off cocks ditto, 56 (2 dangerous); fusible plugs ditto, 2; furnaces out of shape, 14 (5 dangerous.) Total, 149 (12 dangerous). Boilers without glass water gauges, 17; without pressure gauges, 7; without blow-off cocks, 53; without back pressure valves, 87; while a single boiler was found without any independent safety-valve, having only the limited use of one in partnership with another boiler, the connection to which depended on the junction valve being open. An explosion of a most fatal character, resulting in the loss of no less than six lives, has happened during the past month; while another, which took place in the preceding one, in addition to the five referred to in the last monthly report, occurred to a locomotive boiler, in consequence of the plates being internally corroded to $\frac{1}{8}$th of an inch in thickness. Not one of these boilers, however, was under the inspection of this Association. In the first of the above cases the boiler was a vertical one, and had been at work for eight years. It was set so as to utilise the waste heat of one or more iron furnaces, the flames from which first surrounded its lower half, and then passed into a central internal-descending flue through openings in its side. Its outer shell was egg-ended in shape, the height being 21ft. 3in., the diameter 9ft., and the thickness of the plates $\frac{7}{16}$ in. In the internal-descending flue the diameter was 4ft. 8in., and the thickness of the plates $\frac{5}{8}$ths all over. The crown, which was attached to the flue by means of an angle-iron only $\frac{3}{8}$ths of an inch thick, was formed by two plates, a seam of rivets running across the centre, and was stated to have been cambered at 4in., upon which—since it was not strengthened by any stays whatever—it entirely depended for stiffness and power to resist the downward strain tending to collapse. The boiler had been fitted with two safety-valves, loaded to about 50lbs. on the square inch, one of them a dead-weight valve, and both of very ample area, the diameter of each being 6in.; also, there had been a self-acting alarm float, with other necessary gauges and feed apparatus. I examined the boiler the day after the explosion happened, and found that it had flown upwards through the roof of the building, when, being caught with a strong north-east wind blowing at the time, it had been carried a considerable distance, and landed on an adjoining mound of earth. It is probable that, had there been less wind, it would have fallen on the building, and thereby not only have crashed in the roof and machinery in its fall, but added considerably to the loss of life. As the explosion occurred just at daybreak, no reliable observations were made of its flight; but, from the chimneys it cleared in its course, it must evidently have soared to a considerable height. It is remarkable that five out of eight weights of flat disc, or cheese shape, with which the direct acting safety-valve had been loaded, retained their position on the boiler throughout its flight, although they had no other attachment to it than the stability afforded by the safety-valve as a base upon which they were piled. Judging from the position in which they lay, they appear only to have broken away on the shock of the boiler coming to the ground. The cause of the explosion was apparent at a glance. The entire crown of the vertical-descending flue had been blown out, the angle-iron by which the crown was attached to the sides of the flue being rent at the roof completely round the whole circle. The two circular seams of rivets in this angle-iron were both undisturbed; one retaining a part of it on the cylindrical sides of the flue, while the other held the remainder to the crown-plate, with which it was carried away entire. Evidence was adduced at the inquest to prove that the failure of this angle-iron resulted from overheating of the plates, consequent on shortness of water; the line of argument adopted being that no pressure the boiler could have sustained would have been sufficient to have shorn the angle-iron unlesss red hot, and experiments were instituted which were stated to prove that nothing less thau a pressure of 1260lbs. on the square inch could have rent the boiler as it had been unless the plates had been heated from shortness of water. The jury brought in a verdict of manslaughter against the attendant, on the ground of negligence, and he was consequently committed for trial at the approaching Assizes. I beg to differ most decidedly from the above evidence, and to take the following view of the failure of the angle-iron, which will be readily understood by those of our members who have watched the tendency of the front plate in their double-flued boilers to groove. The total pressure on the crown plate was about 50 tons, the whole of which had to be borne by this $\frac{3}{8}$th angle iron, which was much too light for the duty. This load would vary with every alteration in the pressure of the steam, and be entirely removed when the boiler was at rest, and re-imposed when the steam was again got up. These constant variations of load would produce an alternating movement in the angle-iron, which would fret and rapidly deteriorate it, rendering fracture ultimately inevitable, and its occurrence merely a matter of time. It is to this cause, continued incessantly through eight years—the life of the boiler—that I attribute the failure of the angle-iron, and consequently the explosion, and not to shortness of water. I cannot doubt that an application of the hydraulic test would have detected this weakness in the angle-iron in time to have prevented the explosion, the occurrence of which affords an illustration of the hazard of trusting so much to a single angle-iron; and the fact of 99 having proved trustworthy is no guarantee that the hundreth may not fail, as in the present instance. It is always bad engineering to trust so much to a single thread, especially where loss of life may occur from its failure. It will be remembered that in the last monthly report it was stated that three boilers, working side by side, had been reported to have exploded simultaneously, the occurrence being attended with loss of life to the engineman. I have since then visited the scene of the explosion, and found the report a true one, while the injury caused to the surrounding property was beyond any I had before witnessed. These boilers had been of plain cylindrical egg-ended construction, fired underneath, and about 30ft. long, which, in addition to a Cornish one, with a single flue, had originally worked side by side, being all connected together. The latter being out of work at the time, escaped, or, from the injuries it received from the explosion of the others, would certainly have shared their fate. The egg-ended boilers had rent in the main, at the tranverse seams, and the portions had flown more than a quarter of a-mile apart. One of these had alighted on a cottage, which it had seriously damaged; another into a reservoir; the egg-ends flying to the greatest distance, and smaller fragments falling nearer their original seat. The chimney, as well as a blast furnace, were brought down aud reduced to a heap of ruins by one of the egg-ends in its flight; while a second furnace had the feeding gallery at its top dismantled. The roof of the adjoining engine-house was completely stripped of its covering, and the woodwork shifted bodily, breaking one of the engine beams by its movement. The original seatings of the boilers were reduced to an unintelligible heap, while bricks, and the *debris* generally, were scattered like grape-shot over the surrounding land in every direction. The Cornish boiler had been blown from its seat, and so strained by its fall that it had rent at the bottom of one of its transverse seams, as well as at the front plate at the junction of the furnace tube. The cause of the explosion was again attributed, as in the proceeding instance, to shortness of water, consequent on the negligence of the attendant, who, it was supposed, had first allowed the plates to become overheated, and then suddenly admitted a rush of cold water. I carefully examined the parts, with a view of ascertaining how far this supposition was correct, but could not come to the conclusion that it was proved to be so. The supply of the feed to the boilers was found, on examination shortly after the explosion, to be cut off, which contradicted the supposition that a rush of cold water was let in immediately before its occurrence. Again, the engine had been at work for about a quarter of an hour, and had the explosion been caused by a sudden pressure of steam, generated by the dash of water upon heated plates, it would have taken place immediately on the starting of the engine. On consideration of the whole of the circumstances, which space forbids recounting in detail, I think it most probable that, in the first instance, one of the boilers rent over the fire, at a transverse seam, the treachery of which in these under-fired boilers is so common, and to instances of which the attention of the members has been called in the Reports. Plain cylindrical boilers rending in this way always fly a great distance, as these had done, having time, while in the act of completing the rent from the bottom to the top of the tranverse seam, to take a sufficient angle of elevation both for the clearance of obstacles and the attainment of long range. The escape of water and steam from this opening at the bottom of the boiler would destroy the brick seating and blow up the sister ones, which, falling again on an irregular bed of loose brick, would become so strained as to rend, just as the empty Cornish boiler already described had done, and which in boilers having their steam up would be inevitably followed by explosion. I consider the above a further illustration of the inferiority of external to internal firing, and would point out that every one of the five explosions reported during the last month happened not to internally but to externally fired boilers, and I am increasingly impressed with the fact that this district has done wisely in selecting the Cornish type of boiler in preference to the plain cylindrical egg-ended one, and that, not only on the ground of efficiency and economy, upon which there can be no question, but also as regards safety.

Boiler Explosion at Wolverhampton.—On the 15th ult. a boiler explosion happened about two miles from Wolverhampton, causing the immediate death of nineteen persons, and serious injury to many others, some of which have since proved mortal. The site of the explosion is Priestfield, the first station between Wolverhampton and Birmingham, on the Great Western line. At Priestfield, among other iron works are those now carried on by Mr. Thomas Rose, and belonging to the Birmingham Banking Company. The works are called the Milfield Works, and they consist of two forges and three mills, all for the manufacture of different descriptions of finished iron. One forge, the only one now at work, consists of twenty puddling furnaces, a shingling hammer for beating the dross from the balls of molten iron which are produced at the puddling furnaces, and a train of rolls for rolling the iron after it leaves the shinglers' hammer into puddled bars, preparatory to it being cut up, reheated, and rolled into merchantable iron in the mills. The engine which worked the massy shinglers' hammer and the puddled bar rolls was of 80-horse power, high pressure, and supplied with steam fron two cylindrical boilers, with hemispherical ends, eight or nine feet diameter, by about twenty feet long. Each boiler was heated by the superfluous flame from a set of puddling furnaces, and was seated upright on one of its ends. One boiler was heated by the flues of four furnaces, and the other by the flues of two furnaces. The other four furnaces were unconnected with any boiler. At the time mentioned the puddlers were working at the four furnaces attached to the boiler No. 1, were taking out their charges, and were dragging their red-hot balls of iron to the shinglers' hammer, and thence to the puddled bar rolls, the furnaces having been for a quarter of an hour previously working at the utmost heat required in the operation, and the boilers consequently under the same proportionate influence. In fact, the whole of the machinery of the forge was in full operation, and beneath the roof which covered the whole there were about forty men at work. When everything was supposed to be safe, and without any previous warning, a report as of a peal of thunder, immediately overhead was heard. The entire forge was a complete wreck. No. 1 boiler had exploded, Three-fourths of it, weighing about eight tons, had been forced into the air to a height of between 200 and 300 feet, and the remainder in three portions had been driven through the forge in three different directions, tearing down the iron pillars which supported the room, and rending the massive timber beams which rested upon them into splinters. At the same time the brickwork and masonry of the furnaces, with their contents of molten iron and the burning coals from their fires, completed the catastrophe. Before the flying *débris* men were driven bleeding and lifeless, some into boats lying upon the adjoining canal, another over a brick wall twenty yards distant from the boiler, and others were buried beneath the molten iron, the burning coals, and the red-hot brickwork. The damage done to the works is estimated at between £2000 and £3000; they were built about eleven years ago, and until the beginning of last month had been unoccupied about four years.

ACCIDENTS TO MINES, MACHINERY, &c.

Pit Shaft Accident.—On March 29th an accident happened in the pit shaft of Seaham Colliery, in the county of Durham, of precisely the same character as that which occurred in Hartley Pit, and the loss of life might have been double that of Hartley, had there not been a door of escape such as was suggested at the period of the Hartley Pit accident. About half-past eleven in the forenoon, while between 300 and 400 men and boys were employed down in the mine, one of the cages, the one coming up the shaft, got out of the "skeets," or guides which serve to keep it in position while going upward or downward, and the consequence was that it came into violent collision with the cage that was descending at the same moment. The shock of the collision drove the loosened cage forcibly against the brattice work which divides the shaft (which is a single one), and about ten fathoms of it was carried away. Part of the timber went down the shaft, and the remainder fell crosswise, blocking up the shaft pretty much in the same manner as at Hartley, but not to the like extent. Unlike Hartley, however, a way of escape had been provided for the miners in case of an accident of this character. A connecting road had been made into Seaton Colliery—and in a very short time every soul was in safety on the bank. The Seaham pit shaft is walled throughout with smoothly-finished masonry, except where it passes through a stratum of solid rock, and therefore no heavy stone or rubbish has fallen to complete the choking up of the shaft as at Hartley.

MINES METALLURGY, &c.

Tin-Plates.—In the manufacture of tin-plates, Mesrs. Kelly and Shakspeare, of Dudley, propose to employ an invention, which consists of two machines, one being used for scouring and cleaning the plates, or sheets of iron, prior to their immersion in the bath of molten tin, and the other for cleaning off the grease and polishing the surface after they are coated. The scouring-machine consists essentially of three pairs of rolls, the first and third pair being guide rolls, and the middle pair having brushes on their cylindrical surfaces. The said rolls are situated horizontally, and a hopper, containing a mixture of sand and water, is situated over the upper roll of the middle pair, and the lower roll of the said middle pair dips in a trough, also containing sand and water. Behind this pair of rolls are fixed brushes, which remove any sand that may be left adhering to the scoured plates. The polishing-machine consists of nine pairs of rolls, the alternate pairs being guide rolls, and the four intermediate pairs polishing rolls, which are covered with woollen or sheepskin, and kept supplied with sharps from hoppers.

Carbon in Iron.—Weyl has given an ingenious and simple method of determining the quantity of carbon in cast-iron and steel without the previous difficult and laborious pulverization of the metal. The method consists in making the iron to be analyzed the positive electrode in dilute chlorhydric acid, when the iron dissolves, leaving the carbon, and without evolution of gas. To prevent the iron from becoming passive, which would produce an evolution of chlorine, it is only necessary to regulate the strength of the current by adjusting the distance of the electrodes from each other, so that only protochlorid of iron is formed; the formation of the sesquichlorid is indicated by the yellow color of the solution. A single Bunsen's element is sufficient, and the iron dissolves as protochlorid, leaving the carbon as a pseudomorph. The iron to be dissolved may be held in a forceps provided with plantinum points, but so that the points of contact between the platinum and the iron cannot be moistened by the liquid. The separated carbon is to be collected upon an asbestos filter, dried in a current of air, and burned with oxyd of copper and oxygen in the usual manner. The weight of the iron dissolved is easily found by weighing the portion which remains between the platinum points and the surface of the acid, after the complete solution of the immersed portion. A number of analyses conducted according of this method gave results which closely corresponded, and which were usually a little higher than those obtained by the ordinary methods. With respect to the time required, the anthor remarks that a piece of cast-iron weighiug about eight grammes, is dissolved in twenty-four hours.

Coal Mining in Vancouver's Island.—An influential company, has been formed for working some valuable seams of coal beneath 6193 acres of land at Vancouver's Island. The Vancouver Coal Mining Company is constituted upon the limited liability principle, and the capital has been fixed at £100,000, in shares of £10 each. The coal fields were successfully worked by the Hudsons's Bay Company, and all the necessary machinery and plant is on the spot; wharfs, and harbour accommodation of the best kind having also been provided. As the Hudson's Bay Company have surrendered their territorial rights, it has been decided to sell the coal mines which have been acquired or behalf of the projected company, upon very favourable terms. The value of the seams is confirmed by the details given by the Government surveyors, and they have been favourably reported on by Mr. George Robinson and Mr. Nicol.

Collieries in the United Kingdom.—The number of collieries in the United Kingdom is stated, in the last published returns, to be 2949, and the quantity of coal raised annually 72 millions of tons. Of that number 2020 collieries are in England, 443 in Wales, 413 in Scotland, and 73 in Ireland.

Manganese in the Scoria from Old Copper Workings.—M. Terreil has analysed several specimens of scoria from old copper workings in the Island of Cyprus, and has found in them a large proportion (30 per cent.) of sesquioxide of manganese. He calls the attention of metallurgists to the fact, thinking that perhaps the ancient smelters may have found manganese useful in smelting copper pyrites.

APPLIED CHEMISTRY.

Revivification of Animal Charcoal.—M.M. Leblay and Cusinier give a new process for reviving exhausted animal charcoal. They find that the power of absorbing colouring matter is restored on treating the charcoal with weak boiling solution of caustic alkalies. They also say that the original absorbing power of the charcoal may be very much increased by pouring over it a weak solution of biphosphate of lime.

Estimation of Carbon in Iron.—E. Mülder has published a large work on the estimation of carbon in iron, in which, after reviewing all the other processes for estimating and showing them to be more or less defective, he gives the following as the best for the purpose. A long combustion tube of the hardest possible glass is drawn out at the end and plugged with asbestos. The tube is then filled two-thirds full of sand which has been ignited in oxygen. The iron fillings, previously washed with sulphuric acid and then mixed with pumice which has been ignited in oxygen, are now placed in the tube, then a layer of oxide of copper, and lastly a plug of asbestos. A chloride of calcium tube is then connected, also a tube with peroxide of lead to retain sulphurous acid, then a drying tube with sulphuric acid and pumice, and lastly the potash apparatus. A stream of oxygen is then slowly passed, and the tube is heated first gently and then as strongly as possible. The success of the experiment seems to depend a good deal on having enough sand. When is tube was only half full, the author only obtained 4·42 per cent. of carbon. When two-thirds full, he obtained 5·02 per cent.

Action of Iodine on Tin.—M. Personne has proved that when equivalent weights of tin react on each other, only biniodile of tin is formed, half the metal remaining unacted on. The proto-iodide, he says, is never formed when the two bodies act directly on each other. Proto-iodide of tin is only formed by dissolving the metal in a concentrated solution of hydriodic acid, or by double decomposition. The protoiodide combines with oxide of tin in various proportions to form oxido-iodides. The action of iodine on tin is, therefore, exactly similar to the action of bromine and chlorine on the same metal.

On the Construction of Basins and Reservoirs unattackable by most Acid or Alkaline Liquids.—By M. H. Kalisch.—Unless by making use of wrought or cast iron (which have the inconvenience of being easily attacked by all acid liquids), it has been found very difficult to construct reservoirs capable of resisting the action of boiling solutions of caustic alkalies. Most of the materials or luting proposed for this purpose are either much too easily acted on, or are too expensive for application on a certain scale. The author proposes to line the sides of such stone reservoirs with plates or slabs of heavy spar (native sulphate of baryta), and to cement all the joints with a luting prepared in the following manner:—Digest one part of india-rubber, in small pieces, with two parts of freshly rectified spirit of turpentine until the mixture becomes perfectly homogeneous, then incorporate with it four parts of powdered sulphate of baryta. Reservoirs constructed in this way ought to resist not only the corrosive action of boiling caustic alkalies, but most organic or inorganic salts,—for instance, sulphates, chlorides and nitrates of zinc, iron, copper, soluble glass, cream of tartar, &c., and boiling hydrochloric, phosphoric, boracic, oxalic, tartaric, and citric acids, and slightly diluted cold sulphuric acid.

Preparation of Pure Nitrate of Silver.—By M. Lienau.—Attack cuprous silver containing copper by nitric acid; to the solution, sufficiently concentrated, add chlorine water, freshly prepared, which precipitates the silver only. Then wash the precipitate in chlorine water, which prevents the chloride of silver from decomposing under the influence of light, and renders it more speedily soluble in ammonia; when well washed, dissolve it in the liquid, and plunge into the solution a well-cleaned copper wire. As the copper dissolves, the silver is precipitated, and is deposited as a brown powder; the operation is at an end when the wire preserves its brightness after being washed in water.

Separation of Tartaric and Citric Acids.—Add to the solution to be tested an excess of hydrated oxide of iron, and heat almost to boiling. Allow the excess of iron to deposit, decant the reddish-yellow clear liquid, and evaporate to a syrupy consistence. If the citric acid be pure, the residue remains red and clear, but the presence of a very minute quantity of tartaric acid (one centigramme) gives it a cloudiness, and tartrate of iron is deposited.

APPLICATIONS FOR LETTERS PATENT.

Dated March 25, 1862.

819. E. Molyneux, jun., Seaview, Enniskerry—Air, gas, and vapour engines.
820. A. H. Renton, 14, Royal Avenue-terrace, Chelsea, and E. Cottam, of Pimlico—Apparatus for steering ships.
821. W. Beaumont and J. W. Edge, Manchester—Sights for rifles.
822. A. Fryer, Manchester — Manufacture of sugar, and separating liquids from sugar and other substances.
823. A. M. Silber, Wood-street, City—Fastening for purses, pocket-books, bags, and other articles.
824. T. Guibal, Mons, Belgium—Ventilators for the ventilation of mines and furnaces.
825. E. Morewood, Stratford, and A. Whytock, St. Martin's-lane—Manufacture or shaping of iron or other material.
826. W. Palmer, Sutton-street, Clerkenwell—Lamps.
827. C. Culling, Downham Market—fire-arms.
828. W. Clissold, Stroud—Carding engines.
829. J. T. Loft, Brooklyn, New York—Machinery for covering strips of metal and wire.

Dated March 26, 1862.

830. L. De la Peyrouse, 13, Panton-square—Preservation of animal substances.
831. J. H. Johnson, Lincoln's-inn-fields—Apparatus for cleaning tubes and flues of steam boilers and similar conduits.
832. J. Wilson, Glasgow—Apparatus for and in the method of hot-pressing or finishing plaids and other woven fabrics.
833. J. Parker, Huddersfield—Steam engines.
834. W. J. Taylor, King's-road, Chelsea—Colouring Portland cement for plain and ornamental plasterer's work.
835. H. Nunn, Chelsea—Mangles.
836. R. Boby, Bury St. Edmunds—Hay-making machines.
837. J. Boothman, Gisburn—Bee-hives and apparatus connected therewith.
838. J. Taylor and C. H. Minchin, Manchester—Suspender or improved gallery for supporting the shades of gas or other lights.
839. H. Carr, 4, Victoria-street, Westminster — Applying lubricating fluids to the journals of railway carriages and locomotive engines.
840. R. Griffiths, 69, Mornington-road, Regent's-park — Weapons of warfare for naval purposes.

Dated March 27, 1862.

841. W. L. Winans, Brighton—Apparatus for manœuvring ordnance in land fortifications.
842. A. V. Newton, Chancery-lane—Process of and apparatus for separating the fibres of wood, flax, hemp, and other vegetable substances, and extracting the colouring matters therefrom.
843. J. Haworth, 22, Southampton-street, Bloomsbury — Conveying telegraphic messages and signals by means of electricity, without the intervention of any continuous artificial conductor.
844. W. Greenway, Birmingham—Bolts for fastening doors, and for other like purposes.
845. J. D. Schneiter, Paris—Printing the letters, numbers, musical, or other similar characters of maps, plans, sheets of music paper, or other similar impressions, the said method being also applicable to the preserving of printing surfaces.
846. T. G. Greenstreet, 6, Penton-place, Kennington—Window sashes.
847. F. Tolhausen, Paris—Tubes for holding and smoking cigars and cigaretes.
848. R. Edwards, Regent-street, Mile-end — Pulverising, stamping, and washing mineral, animal, and vegetable substances.
849. W. F. Henson, Portland-place, and H. H. Henson, 13, Parliament-street—Wicks for candles and lamps.
850. J. Lock, Nassington—Raising or elevating straw and crops on to stacks.
851. E. H. C. Monckton, 5, Thurloe-place, South Kensington—Manufacture of effervescing liquids.
852. J. L. H. Clémence, Paris—Treating open cocoons of silkworms, and converting the waste resulting therefrom into paper.
853. R. A. Brooman, 166, Fleet-street—Machinery for preparing, combing, and dressing vegetable fibres.
854. R. De Bary, Finsbury-square—Machinery for the manufacture of cigars.
855. J. Easterbrook and J. H. Allcard, Sheffield—Vices.
856. W. E. Gedge, 11, Wellington-street, Strand—Apparatus for extinguishing fire.
857. S. A. Emery, Arundel-street, Westminster—Soap.
858. J. H. Johnson, 47, Lincoln's-inn-fields — Thrashing machines.
859. W. F. Smith and A. Coventry, Salford—Lathes and machines for turning for cutting screws.
860. G. H. Birkbeck, 34, Southampton-buildings, Chancery-lane—Producing imitation mosaics.

Dated March 28, 1862.

861. G. Allcroft, Camberwell—Pressure and vacuum gauges
862. J. Jones, Warrington — Apparatus for raising and forcing liquids.
863. W. A. Ashe, Bolton-place, Middlesex—Driving the propelling shafts of ships or vessels.
864. W. B. Nation, Bagley Works, Battersea—Manufacturing boxes or cases, and machinery or apparatus employed therein.
865. R. A. Owen, Manchester—Feathering and varying the pitch of screw propellers for steamships.
866. E. T. Noualhier, Paris—Ventilator.
867. A. Lucetti, Glasgow—Apparatus for expressing the juice from pulpy fruit.
868. J. H. Johnson, 47, Lincoln's-inn-fields—Chaff-cutters.
869. E. Smith, Hamburg—Wet gas-meters.
870. R. Lublinski, 183 and 185, City-road—Method of jointing crutch-hooks on umbrellas or walking canes.

Dated March 29, 1862.

871. R. Kay, Blue Pits, Lancaster—Printing calicoes and other surfaces, and apparatus connected therewith.
872. J. Boucher, Camberwell—Rifled ordnance and firearms, and projectiles to be used therewith.
873. Y. Parfrey, Pimlico—Breech-loading fire-arms.
874. W. Clark, Gateshead—Apparatus for casting.
875. I. Morris, Wolverhampton—Machine for breaking up or cultivating land.
876. C. H. Townsend, J. Young, and J. Hankins, Bristol.—Removing and preventing incrustation in steam boilers
877. N. Smith, Montague-square, Middlesex—Fire engine.
878. W. Glass, Lambeth—Treatment of sulphuret of antimony, and obtaining products therefrom.
879. T. Cole, Coventry—Manufacture of figured ribbons and other textile fabrics.
880. W. Paterson, Glasgow—Manufacture of iodine.
881. R. Smith, Melksham—Roller blind apparatus.
882. J. Baker, Old Kent-road, Surrey—Alimentary preparations.
883. E. B. Hart, New York—Cutting cork so as to render the same suitable for stuffing purposes.
884. J. Platt and W. Richardson, Oldham—Carding engines.
885. W. E. Newton, Chancery-lane—Applying acoustic apparatus in churches and other buildings and apartments.

Dated March 31, 1862.

886. J. Clinton, Tottenham Court-road—Flutes.
887. M. A. F. Mennons, Paris—Manufacture of glucose or fermentable sugar from a vegetable product not hitherto used for that purpose.
888. J. Jordan, Liverpool—Construction of armour-plated vessels or other like structures.
889. R. Young, Glasgow—Apparatus for cleaning, separating, washing, and drying grain.
890. N. Frankenstein, Mildmay-park, London—Cutting of all kinds of corks, both pointed, conical, and cylindrical.
891. W. Tyler, Birmingham—Composition for feeding dogs and other animals and poultry.
892. W. H. Hook, Walworth—Folding envelopes and paper, and machinery or apparatus employed therein.
893. J. P. Woodbury, Boston, U.S.—Arming war vessels.
894. W. B. Lord, Plymouth, and F. H. Gilbert, Brixton—Hame slip for suddenly releasing horses and other cattle from their harness, also applicable for releasing heavy bodies or weights.
895. W. B. Lord, Plymouth, and F. H. Gilbert, Brixton—Loading fire-arms.
896. R. Burley, Lower Thames-street, City—Material for forming or lining the bearing of axles and shafts, and other rubbing parts of machinery.
897. R. C. Ransome, Ipswich—Thrashing and other machinery where corn or grain is required to be raised from one level to another.
898. R. Nightingale, Maldon—Markers, butts, or mantelets.
899. L. B. Schmolle, Golden-square, Middlesex—Crinolines or steel skirts.
900. J. Harding, Leeds—Application of the waste heat arising from coke ovens for heating air for blast furnaces, also for calcining iron-stone and other minerals, and for heating and smelting iron.
901. J. M. Clements, Birmingham—Sewing machines for performing the various kinds of work necessary in sewing generally.
902. J. H. Johnson, 47, Lincoln's-inn-fields—Rotary engines.
903. H. Pooley, jun., Liverpool—Construction of weighing machines and weigh bridges.
904. W. M. Cranston, 58, King William-street, City—Machinery for cutting corn and other crops.

Dated April 1, 1862.

905. J. T. G. Stone, Hoxton—Bustle and petticoat.
906. P. R. Couchoud, Paris—Loom for manufacturing chenille and other lace-work.
907. C. P. Gontard, Besançon—Stopping piece for watches and other time keepers intended to limit the winding up of the moving spring.
908. W. Clark, 53, Chancery-lane—Manufacture of manure.
909. W. Clark, 53, Chancery-lane—Kneading machines.
910. M. Henry, 84, Fleet-street—Furnace for treating iron ore.
911. W. Turner, Nottingham—Machinery employed in the manufacture of dough, and especially of fermented dough.
912. F. Knudsen, Charing-cross—Chronometers.
913. H. Smith, Stockton-on-Tees—Apparatus used when casting iron or other metal.
914. J. H. Johnson, 47, Lincoln's-inn-fields—Machinery for spinning cotton or other fibrous substances.
915. H. W. Caslon and G. Fagg, Chiswell-street—Casting printing types, and apparatus for rubbing the same.
916. H. W. Whitehead and G. Bray, Leeds—Machinery for carding wool and other fibrous substances.
917. E. Hartley, G. Little, and J. Hinchcliffe, Oldham—Rolling or straightening metal spindles, shafts, or rods of a cylindrical or tapered form.
918. J. Platt and W. Richardson, Oldham—Mules for spinning and doubling.
919. H. J. Madge, Swansea—Coating iron sheets or plates, to be used as a substitute for tin or terne plates.
920. J. Platt and W. Richardson, Oldham—Machinery used for applying motive power derived from bullocks, horses, or other animals.
921. H. Lorenz and T. Vette, Berlin—Filters.

Dated April 2, 1862.

922. W. C. Harrison, Pimlico, and H. J. Standly, Westminster—Instrument or tools for boring or drilling holes in slate or other rock.
923. G. Holcroft, Manchester—Blast furnaces.
924. Rev. G. Scratton, Stickney, Lincoln—Shades or blinds for windows.
925. S. Warren, Ledbury—Machinery for transmitting motion obtained by animal power to agricultural and other machines.
926. R. A. Brooman, 166, Fleet-street—Memorandum, pocket and other books, and in pencil and pen holders to be used therewith.
927. W. Malam, Skinner-street—Manufacture of gas and improved apparatus to be employed in such manufacture.
928. A. V. Newton, 66, Chancery-lane—Bits for taming or subduing vicious horses and breaking colts.
929. G. and J. Collier, Halifax—Looms for weaving carpets and other pile fabrics.
930. B. Blackburn, Adelphi—Apparatus for lubricating locomotive and other axles.
931. S. Hunter, Newcastle-upon-Tyne—Anchors.
932. T. Moore, 33, Regent's-circus—Winding apparatus especially applicable to fishing-lines, nets, and log lines.
933. J. T. Loft, New York—Machinery for printing in colours.
934. W. Clark, 53, Chancery-lane—Manifold writing.
935. W. Leopard, Hurstpierpoint—Railway brake apparatus.
936. W. Clark, 53, Chancery-lane—Manufacture of carbonic acid.

Dated April 3, 1862.

937. G. Rebour, Paris—Permanent autographic log.
938. W. Helme, Caldbeck, Cumberland—Firelighters.
939. R. Morton, Stockton-on-Tees—Refrigerators or apparatus for cooling liquids.
940. G. Bower, Ashton-under-Line, and J. Qualter, Dukinfield—Metallic pistons.
941. J. Newton, Peckham—Breakwaters, piers, and sea walls.
942. G. Hunter, Coleford—Machinery and tools for cutting, sawing, and planing stone, marble, and slate.
943. R. M. Toogood and J. Laybourne, Newport—Railway crossings.
944. W. Kemp, 20 Spital-square, and T. Cowley, Bethnal-green-road—Silk pile velvet.
945. M. Amos, Westbury-on-Tryn, Gloucester—Harrows.
946. D. Wilson, Wandsworth-common, and E. A. Cowper, Westminster—Presses for pressing cotton fibrous materials and hay.
947. J. Lee, Lincoln—Traction engines.
948. A. Mann, Tottenham—Photographic apparatus.
949. W. A. Richards, Holloway — Bags, and fastenings and locks for bags.
950. H. T. Hassall, Birmingham, and M. Burke, Liverpool—Reclining or invalids' chairs, and swinging or ships' chairs.

Dated April 4, 1862.

951. J. F. Woodall, Portman-square—Ventilating carriages for common roads.
952. J. C. Kay, and W. Hartley, Bury—Steam engines.
953. F. Spencer, Pendleton—Looms for weaving.
954. W. Ryder, Bolton-le-Moors — Machines for forging metals.
955. F. C. Bakewell, Hampstead—Letter printing machines
956. T. Silver, Philadelphia—Governors for regulating the speed of steam and other engines.
957. L. Lindley and F. Taylor—Sewing and embroidering machines.
958. H. Fletcher, 5, Cornwall-crescent, Camden-road—Valves for hydraulic presses, and apparatus connected therewith for making or pressing blocks or bricks of coals or other material.
959. G. Moulton, Manchester—Pentagraph machines used for tracing or engraving rollers or cylinders employed in printing calicoes and other surfaces.
960. A. Woodhouse, Barrow-in-Furness, and T. Hunter, Hindpool—Arrangements of kilns and flues for burning brick, tiles, quarries, and other like articles, and in utilising the waste heat of the said kilns, and in stoves for drying bricks, tiles, quarries, and other like articles.
961. A. J. Hale, William-street, Clerkenwell,—Instruments for drawing ovals.
962. M. Butcher, Great Yarmouth—Apparatus for reefing and furling sails from the deck.
963. S. Fielding, S. Fielding the younger, R. Fielding, and T. Fielding, Smallbridge, near Rochdale — Valves and apparatus for lubricating the same, and other parts of steam engines.
964. R. A. Brooman, 166, Fleet-street—Case for holding balls and reels of cotton, silk, and other threads.
965. J. Sceales, Lloyd's, London—Steering ships.
966. W. E. Newton, 66, Chancery-lane—Manufacture of iron and steel.
967. W. E. Newton, 66, Chancery-lane—Pumps for ships' use and other purposes.
968. W. E. Newton, 66, Chancery-lane—Projectiles for ordnance.
969. J. Nock and W. K. Price, Birmingham—Gas cooking ranges.
970. J. D. Humphreys, 11, Aldhous Terrace, Barnsbury—Furnaces and machinery employed in the manufacture of compound fuel and other matters.
971. M. Walker, Gracechurch-street—Breech-loading rifles and other fire-arms, and ordnance.

Dated April 5, 1862.

972. W. Begg, Preston — Consuming smoke, and furnace bars and bridges for effecting the same.
973. H. J. Simlick, Bethnal-green—Vesuvians or cigar lights.
974. J. Colling, Seaham—Apparatus for reefing ships' sails.
975. A. Clark, Lincoln's-inn-fields—Revolving window shutters and blinds in window sash bars and plates, also in apparatus used in such manufactures.
976. L. Faconnet, 52, Rue-du-Transit-Vaurigard, Paris—Tiles.
977. R. A. Kobitzoch, Bucharest, Wallachia—Diving apparatus, and apparatus to be used for working deep water.
978. T. Critchlow, Bolton-le-Moors—Planing machines.
979. B. Thompson, Newcastle-upon-Tyne—Steam engines.

Dated April 7, 1862.

980. C. S. Duncan, Bayswater—Apparatus for ventilating, cooling, or suppressing fire in public or private buildings or rooms.
981. T. Smith, Salford—Machinery for cutting and shaping screw bolts and other articles.
982. W. Simons, Renfrew—Constructing ships or vessels.
983. A. Harris, Birmingham—Gun barrels.
984. E. Welch, Stratford-on-Avon—Register stoves and fire grates, and ovens and kitchen ranges.
985. G. Haseltine, 100 Fleet-street—Lamps especially designed for burning hydro-carbon oils.
986. W. N. Nicholson, Nottingham—Ranges and stoves.
987. T. Jackson, Portman-square—Piano-fortes.
988. J. Wathemez and A. Kloth, Aix-la-Chapelle—Indicating a deficiency of water in steam generators.
989. J. Carrington, Kensington—Paving stables and stable yards.

Dated April 8, 1862.

990. W. Steven, Glasgow—Apparatus for moulding clay for bricks or other like articles.
991. J. Brown, Aldgate—Protecting the bottom and sides of ships and other entirely or partially submerged surfaces.
992. W. Beardmore, Glasgow—Steam rams for naval purposes.
993. H. Levinstein, Old Broad-street—Lustering silk.
994. J. Whitehouse, Birmingham—Metallic door and other knobs, and the ornaments of the pillars of metallic bedsteads and other articles of like manufacture, and in attaching metallic mounts to china or earthenware knobs and ornaments and roses for knobs.
995. Hon. W. E. Fitz Maurice, Hyde-park Gate—Construction of plating for ships' batteries and other structures used for war or other purposes.
996. C. P. Carter, Ashford—Instrument for inserting photographic or other pictures into or removing them from between the mounts of photographic albums or other flat spaces into which the fingers cannot be inserted.
997. F. W. Breary, Cornhill—Medicated cups or vessels for drinking purposes.
998. E. H. C. Monckton, South Kensington—Timekeepers.
999. J. Jaques, jun., Hatton-garden—Instruments used in the game of croquêt.
1000. B. Sharpe, Hanwell-park—Harrows and rakes.
1001. H. A. Holden, Birmingham, and C. Weekes, Carmarthen—Apparatus used in drawing water or other fluids from cisterns, tanks, or other vessels.
1002. E. B. Sampson, Stroud—Apparatus for supplying oil or other liquid to wool, as the same is fed into carding engines.
1003. J. Lawson, Leeds—Balling cotton and thread.
1004. J. Wright, Blackfriars—Joining together armour and other thick metal plates, beams, and girders.
1005. T. Cobley and J. Wright, Blackfriars—Method of and the apparatus for treating auriferous and argentiferous minerals and ores for the purpose of extracting and separating the gold and silver from other metals, minerals, and substances combined therewith.

Dated April 9, 1862.

1006. S. Rodgett, Blackburn—Power looms for weaving.
1007. J. E. H. Andrew, Audenshaw—Looms for weaving.
1008. S. Farron, Ashton-under-Lyne—Machinery for regulating the supply of steam from the boiler to the cylinder or pipes of steam engines, which improvements are also applicable to gases or fluids.
1009. G. Hollinshed, Salford—Sandwich cases.
1010. J. Bullough and J. Bullough, Baxenden—Looms for weaving.
1011. W. Taylor, Oldham—Machinery for preparing and spinning cotton or other fibrous materials.
1012. W. Davies, Llanelly—Puddling, bailing, and reheating furnaces.
1013. J. Jones, jun., Liverpool—Constructing and arming ships and vessels.
1014. J. Langston, Strood—Portland cement.
1015. C. Mather, Broughton—Spittoons.
1016. J. Knowelden, Southwark—Steam, water, and other fluid engines.
1017. W. E. Newton, 66, Chancery-lane — Apparatus for raising and forcing water and other liquids.
1018. W. Mays, Shadwell—Machinery for grinding corn, grain, and other substances.
1019. R. Theyson, Hanover—Cork cutting machinery.

Dated April 10, 1862.

1020. E. Funnell, Brighton.—Self-acting indicator signal for railways.
1021. D. Fryer, Old Kent-road, and J. Williams, Arundel-street, Strand—Method of and apparatus for letting on and cutting off the supply of gas to groups or districts of streets and other lamps from a central point or depôt.
1022. W. Armitage, Manchester—Looms for weaving.
1023. W. Nunn, 179, St. George-street—Lanterns for ships and signals.
1024. J. Houghton, Cheapside—Improved haversack.
1025. A. Black, Banbridge, Down—Swing bridges adapted for crossing lines of railways.
1026. J. Lillywhite, Euston-square, and T. Nixon, Chelford, Chester—Bowling apparatus for cricket balls, to be called the balista.
1027. C. P. Coles, Southsea—Masts for ships.
1028. G. D. Mertens, Margate—Preparation of materials to be employed in the making of beer, and the machinery or apparatus employed therein.
1029. L. Christoph, Paris, W. Hawksworth, Linlithgow, and G. P. Harding, Paris — Drawing metals, and the machinery employed therein.
1030. H. Deacon, Appleton—Caustic soda.
1031. J. Platt, W. Richardson, Oldham, and W. Holland, Salford—Carding engines.
1032. J. Petrie, jun., Rochdale—Machinery for blowing and exhausting air.
1033. G. Burge, Regent's-park—Protecting forts, ships, and other places and structures against projectiles and other striking bodies.
1034. C Bartholomew, Broxholme, and J. Heptinstall, Masbrough—Circular blooms, such as are used in the manufacture of tyres, and for other purposes.
1035. O. Reynolds, Debach, Woodbridge.—Building ships and other vessels.
1036. T. B. Taft, Westminster—Coverings for the feet.
1037. W. Fox, Amiens—Brooms and brushes.
1038. A. Trimen, Adelphi—Protection and solidification of magnesian limestone and other stones, and for the prevention of the passage of water through the same.

Dated April 11, 1862.

1039. H. Holland, Birmingham — Manufacturing the stretcher joints of umbrellas and parasols.
1040. J. T. Grice, Birmingham—Manufacture of twisted metallic tubes.
1041. E. H. Carbutt, Bradford—Pistons.
1042. J. Garnett, Windermere—Apparatus for washing photographic pictures.
1043. W. E. Gedge, Strand—Improved lamp for lighting mines.
1044. J. F. Mathias, Paris—Apparatus for pressing and ironing straw hats of any shape or form.
1045. F. Rigollot, Paris—Machinery or apparatus for manufacturing riveting pegs for boots and shoes, and other pins or pegs.
1046. J. M. Landmann, Ste. Croix, Algeria—Hydraulic engines.
1047. T. Knowles, J. Houghton, W. Knowles, and W. Houghton, Gomersal, York—Looms for weaving.
1048. E. Butterworth, Rochdale—Machinery for applying adhesive substances to preserve the form of cops of yarn.
1049. W. Clark, 53, Chancery-lane— Leathern accoutrements.
1050. W. Bush, Tower-hill—Ships and shields.
1051. J. H. Johnson, 47, Lincoln's-inn-fields—Fire-arms.
1052. J. Howard, E. T. Bousfield, and T. Phillips, Bedford—Steam cultivation.
1053. I. Whitesmith, Glasgow — Power looms, and pirn winding apparatus.

Dated April 12, 1862.

1054. J. Bunnet, Deptford — Revolving shutters, and machinery for producing the same.
1055. N. Nussey, Holbeck, Leeds—Machinery for preparing and combing wool, flax, hair, cotton, silk, and other fibrous materials.
1056. E. Bollée, Le Mans, France—New hydraulic ram.
1057. A. Sweet, Hampstead—Locks and latches.

1058. E. Drewett, Blackheath—Bottles and vessels whereby to separate and retain sediment from their contents.
1059. A. S. Campbell, Hampstead—Surface condensers.
1060. A. S. Campbell, Hampstead—Refrigeration of liquids.

Dated April 14, 1862.

1061. J. Park, Bury—Steam engines.
1062. E. Peyton and W. F. Batho, Birmingham—Angle iron, applicable to metallic bedsteads, roofs, bridges, and other similar purposes.
1063. J. F. Spencer, Newcastle-on Tyne—Steam engines.
1064. H. C. Lee, 11, Laurence Poulteney-lane, City—Knitting machines.
1065. F. Tolhausen, Paris—Telegraphic dial printing apparatus.
1066. J. Beard, Leonard Stanley, Gloucester—Sofa beds or sofa bedsteads.
1067. J. M. French, Birmingham—Upright pianofortes.
1068. J. Darlington, 26, Gresham-street, City—Arrangement of marine telegraph wires and cables.
1069. J. K. Hampshire, Whittington, Derby—Safety cage with disconnecting catch to prevent accidents in the working of coal or other mines, arising from the overwinding or breaking of the ropes or other parts used for hoisting purposes.
1070. J. Dargue, Bradford—Machinery for preparing and combing wool and other fibrous materials.
1071. C. Harratt, Highgate—Masts, yards, and booms.
1072. J. Childs, Pimlico—Wax matches.
1073. R. A. Brooman, 166, Fleet-street, City—Reaping and mowing machines.
1074. R. A. Brooman, 166, Fleet-street, City—Carriages for transporting loads on railways, common roads, and other surfaces.
1075. R. A. Brooman, 166, Fleet-street, City—Pumps.
1076. R. A. Brooman, 166, Fleet-street, City—Hobby horse.

Dated April 15, 1862.

1077. C. J. Coxhead, Kentish Town—Pianoforte actions.
1078. G. Fell and W. Haynes, Bolton—Machinery to be used in the manufacture of leather.
1079. J. Taylor, Oldham—Machinery for preparing cotton or other fibrous materials to be spun.
1080. T. H. Bennett, Southwark—Hats, caps, or other coverings for the head.
1081. F. A. Le Mat, New Orleans, and C. F. Girard, Washington, U.S.—Construction of revolving and repeating fire-arms, part of which invention is also applicable to other arms.
1082. R. Roche, Southsea—Gun carriages.
1083. C. R. Heap, Westminster—Railway chair.
1084. A. V. Newton, 66, Chancery-lane—Manufacture of blasting powder.
1085. G. Bedson, Manchester—Wire ropes, and in the preparation of wire for such manufacture.
1086. J. Platt and W. Cheetham, Oldham—Looms for weaving.
1087. J. Platt and W. Richardson, Oldham—Machinery for cleaning wool and other hairs of animals from burrs and other foreign matters.
1088. R. A. Peacock, St. Helier, Jersey—Constructing and working lock gates for docks, harbours, canals, and navigable rivers.
1089. W. Clark, 53, Chancery-lane—Ornamenting fabrics and other surfaces.
1090. T. W. Gray, Fenchurch-street,—Manufacture of explosive compounds.
1091. F. C. Philippson, Berlin—Steam hammers.
1092. J. Crossdale, Islington—Boots and shoes, for ventilating same.
1093. R. Rains, Blackfriars—Apparatus for freezing, cooling, and churning.

Dated April 16, 1862.

1094. S. Barrett, Finsbury—Projectiles.
1095. F. N. Gisborne, London-bridge—Electric targets for rifle and gun practice.
1096. T. Edwards and J. Harrison, Liverpool—Letter-receiving boxes and other like receptacles.
1097. J. Barbour, Liverpool—Upholsterers' and other hand hammers.
1098. W. F. Lock, Ryde, Isle of Wight—Elongated projectile to be shot from smooth-bored ordnance, and which shall retain during its flight the longer axis in the direction of its line of flight, similarly to elongated projectiles propelled from rifled ordnance.
1099. J. W. Hadwen, Halifax, York—Treatment and application of soft silk waste.
1100. D. Stott, Stainland, York—Rings from paper, millboard, or pasteboard, applicable for steam or other pipejoints, bobbin ends, or other purposes, and in the means or apparatus employed therein, which are also applicable to the manufacture of rings from other flexible substances.
1101. J. Mackay, Liverpool—Projectiles for fire-arms.
1102. J. M. Rowan, Glasgow—Articles of cast-steel.
1103. R. Cochran and R. Cochran, jun., Paisley—Ornamental fabrics.
1104. F. P. Wharrau, East Court, Cosham—Apparatus for steering sea-going vessels.
1105. M. Cartwright, Hoxton—Manufacture of models, and of plates or pieces for artificial teeth, and in combining or amalgamating india-rubber and gutta-percha with metals for the manufacture of artificial plates or pieces, and for other purposes.
1106. W. J. Marsden, Sheffield—Eye-shades.
1107. W. E. Newton, 66, Chancery-lane—Setting artificial teeth.
1108. W. E. Newton, 66, Chancery-lane—Cannon and other ordnance, and of solid and hollow cylinders for shafting and other purposes of wrought-iron or steel, or both combined.
1109. J. Stanton, Birmingham—Apparatus to be used in stamping or piercing metal washers and other similar articles.
1110. J. H. Johnson, 47, Lincoln's-inn-fields—Machinery for cutting the teeth of wheels, racks, or segments.
1111. J. Ashbury, Manchester—Permanent way of railways.
1112. J. H. Johnson, 47, Lincoln's-inn-fields—Railway and common road carriages.
1113. J. W. Ford, Shooters-hill, Kent—Sewing machines.
1114. J. Weston, St. Luke's—Machinery for morticing, drilling, and dove-tailing, and in tools to be used therewith.

Dated April 17, 1862.

1115. C. D. Abel, 20, Southampton-buildings, Chancery-lane—Chromates and bichromates of potash and soda.
1116. A. Krupp, Essen, Prussia—Screw Propellers.
1117. V. Fleury, Paris—clocks and other timekeepers.
1118. W. H. Hutchinson, Bury—Manufacture of ammonia or its salts and cyanogen or its compounds from refuse gluten.
1119. J. Griffiths, Liverpool—Propelling ships and other navigable vessels.
1120. W. Harling, J. M. Todd, and T. Harling, Burnley—Looms for weaving.
1121. F. Tolhausen, Paris—Machine for making bricks, tiles, and the like articles.
1122. J. Murphy, sen., Glasgow—Looms.
1123. J. P. Temperley, Bolton-le-Moors—Air pumps of steam engines.
1124. G. T. Bousfield, Loughborough-park, Brixton—Sewing machines.
1125. J. L. Perin, Paris—Machinery for morticing wood.
1126. H. Gardner, Leeds—Machinery for breaking and preparing flax and other fibrous substances.
1127. C. D. Abel, 20, Southampton-buildings, Chancery-lane—Manufacture and production of certain alloys containing cadmium.
1128. R. A. Brooman, 166, Fleet-street—Tap and valves.
1129. R. A. Brooman, 166, Fleet-street—Buffing apparatuses and in draw springs.
1130. W. Anderson, 85, Shaftesbury-street, Middlesex—Tubular steam generators.
1131. H. Gallagher, Bermondsey—Overalls, leggings, or in overboots.
1132. S. Rideal, Manchester, and R. Shepherd, Great Grimsby—Railway break apparatus.
1133. W. Clark, 53, Chancery-lane—Manufacture of railway rails.
1134. J. C. Rivett, Farnworth, and J. M. Hetherington, Manchester—Machinery for preparing cotton and other fibrous materials for spinning.
1135. R. Wedgwood, Barnes—Apparatus for facilitating the saving of life in cases of fire.

Dated April 19, 1862.

1136. R. Dennison, Lancaster—Reaping and mowing machines.
1137. E. Dove, Hunter-street—matches and fuzees, and apparatus for containing and igniting the same.
1138. J. S. Phillips, 10, College-crescent, Finchley-road—Apparatus for the propulsion of vessels through the water.
1139. J. Shanks, Barrhead—Apparatus for promoting ventilation, also applicable to drying stoves.
1140. M. Masters, New Kent-road—Artificial legs.
1141. R. Stuart, G. Stuart, and H. Hill, Sheffield—Fastening flyers upon spindles.
1142. B. Rhodes, Old Ford-row, Bow—Machinery for and in the method of making, as also in the materials to be employed in the manufacture of cylinders, tubes, and other vessels from paper and other materials or fabrics.
1143. W. Munn and D. Ballantine, jun., Borrowstounness—Mills for grinding.
1144. B. Browne, 52, King William-street—Breech-loading fire-arms.
1145. E. Loysel, Cannon-street—Locks and fastenings.
1146. W. Rose, Hales Owen, Worcester—Manufacture of tubes, more especially applicable to the barrels of fire-arms and ordnance.
1147. A. Parkes, Birmingham—Manufacture of rollers for surface printing and embossing.
1148. A. N. Wornum, Store-street—Piano-fortes.
1149. A. Parkes, Birmingham—Surface condensers.
1150. H. Lumley, Chancery-lane—Improved rudder.

Dated April 21, 1862.

1151. A. P. Tronchon, Paris—Construction of houses, murals, mobil palisads, fruit walls, and other analogous objects.
1152. J. Combe, Belfast—Machinery for hackling flax and other fibrous substances.
1153. E. H. C. Monckton, South Kensington—Apparatus to be used in warfare, parts of which are applicable to other useful purposes.
1154. J. Pickard and T. Morris, Preston—Furnaces for the prevention or consumption of smoke.
1155. S. P. Matthews, Wolverhampton—Vices.
1156. S. F. Griffin, New Adelphi Chambers—Construction of vessels of war and batteries on land.
1157. A. Marks, Cannon-street-road—Ornaments of dress.
1158. E. F. Clarke, Waterloo, Liverpool—Propellers or steamships and other vessels.
1159. R. A. Brooman, 166, Fleet-street—Packets or protectors for covering metal and other surfaces to prevent loss of heat by radiation.
1160. F. Tolhausen, Paris—Horse-shoes.
1161. T. Attwood, Lewes—Kitcheners.
1162. C. Callebaut, Paris—Sewing machines.
1163. A. Dixon, Birmingham—Fork cleaning machines.
1164. J. C. Amos, Southwark—Apparatus for surface condensers with water, part of which improvement is applicable to blowers and rotary pumps generally.
1165. C. C. Creeke, Bournemouth—Construction of drain and other pipes.

Dated April 22, 1862.

1166. T. Lea and S. Smith, Smethwick, Staffordshire—Burglary alarms or indicators.
1167. E. H. C. Monckton, Thurloe-place, South Kensington—Umbrellas, parasols, awnings, tents, and covering cloths, and in waterproofing the same.
1168. S. S. Putnam, Dorchester—Machines for forging horse shoe nails and other articles.
1169. C. E. Elliott, 5, Aldermanbury Postern—Preparation of dried yeast.
1170. C. Webster, Radford—Self-acting fountains, adapted for garden engines, fire engines, and for raising and forcing water from mines, wells, and other places.
1171. A. Warner, Threadneedle-street—Construction of vessels of war and in floating or other batteries.
1172. J. H. Johnson, 47, Lincoln's-inn-fields—Apparatus for propelling and manœuvring ships.
1173. G. Scoville, Wood's Hotel, Furnivals Inn—Pistons for steam engines.
1174. R. Boby, Bury St. Edmunds—Apparatus for rolling or crushing land.

Dated April 23, 1862.

1175. R. Jinks, 20, Upper King-street, Bloomsbnry—Apparatus for suspending, raising, and lowering Venetian blinds, and for retaining them and other blinds, and also curtains and sun shades, at any required heighth.
1176. L. Holden, Burnley—Harness for animals of draught and burden.
1177. W. Moir, Manchester—Instrument for ascertaining the specific gravity of liquids.
1178. G. N. Bates, New Bashford, Nottinghamshire—Dressing lace and other fabrics.
1179. G. H. Birkbeck, 34, Southampton-buildings—Lubricating apparatus.
1180. W. Carpenter, Greenwich—Printing in colours.
1181. J. Price, Dundalk—Spikes for railways and other purposes, and in the mode of manufacturing and securing the same.
1182. A. Robertson, Dublin, and R. Barter, St. Anne's, Blarney—Apparatus for distributing and projecting fluids either for surgical, sanatory, or domestic purposes.
1183. W. Fear, jun., Bristol—Joining the saw plates of veneer and other saws constructed in segments.
1184. A. Hodgkinson, Belfast—Composition to be used in the process of boiling, preparing, or bleaching vegetable substances, whether they are in the manufactured or unmanufactured state, which mixture may also be used in the manufacture of soap.
1185. J. H. Johnson, 47, Lincoln's-inn-fields—Apparatus for taking deep sea soundings, and for recording the speed of ships.
1186. G. T. Bousfield, Loughborough-park, Brixton—Elliptic springs for wheel carriages and other purposes.
1187. A. V. Newton, 66, Chancery-lane—Looms for manufacturing tufted pile fabrics, and in the mode of operating such looms.
1188. W. E. Newton, 66, Chancery-lane—Fertilizing composition.
1189. W. E. Newton, 66, Chancery-lane—Imitation of lace, net, or openwork fabrics.
1190. C. E. Heinke, 79, Great Portland-street—Diving helmets, dresses, and apparatus, parts of which improvements may also be employed for extinguishing fires in ships and other confined places.

Dated April 24, 1862.

1191. J. Endean, Walworth—Cocks, taps, and valves.
1192. W. Haggett, Sherborne—Locomotive engines and carriages for railways, part of which improvements are applicable to carriages and vehicles for tram and common roads.
1193. H. Wheatley, Mirfield, York—Steam for heating or drying purposes.
1194. J. Bond, Burnley, Lancashire—Projectiles, which improvements are applicable to horns attached to vessels for war purposes.
1195. W. D. Ruck, 8, Duke-street, London-bridge—Grease from coal tar, coal oil, creosote, or dead oil.
1196. J. Winsborrow, Dalston—Wet gas meters.
1197. G. Davis, Holloway—Matting, and in apparatus for the same.
1198. J. Traversier, Finsbury—Ladies' bonnets.
1199. J. F. Allen, New York—Slide valves and valve gear for steam engines.
1200. G. W. Belding, Cheapside—Harrows or Cultivators.
1201. F. Dangerfield, Westminster, Lithographic or zincographic presses.
1202. R. Mushet, Coleford—Lining, repairing, or 'fettling' of puddling furnaces.
1203. J. Offord, Oxford-street—Carriages.
1204. R. Zimara, St. Petersburg—Stoves for heating and ventilating buildings.
1205. T. W. Ashby, Stamford—Apparatus for obtaining motive power from the wnd.

LARGE PLATE-SHEARING MACHINE,

MANUFACTURED BY MESSRS JOHN YULE & Co ENGINEERS.

GLASGOW.

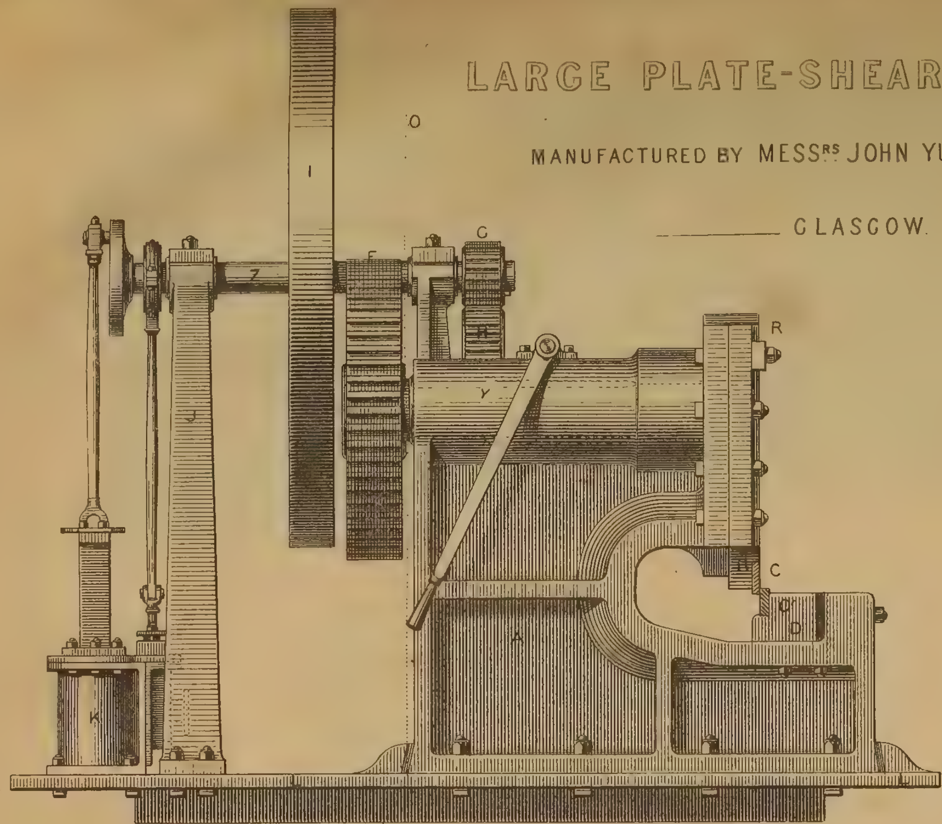


FIG. 1. ELEVATION.

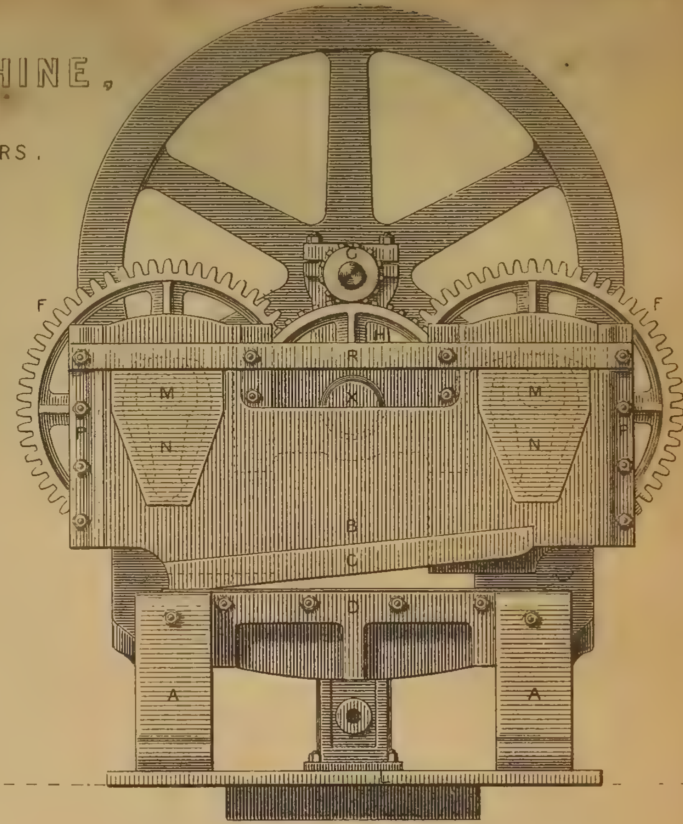


FIG. 3: END ELEVATION

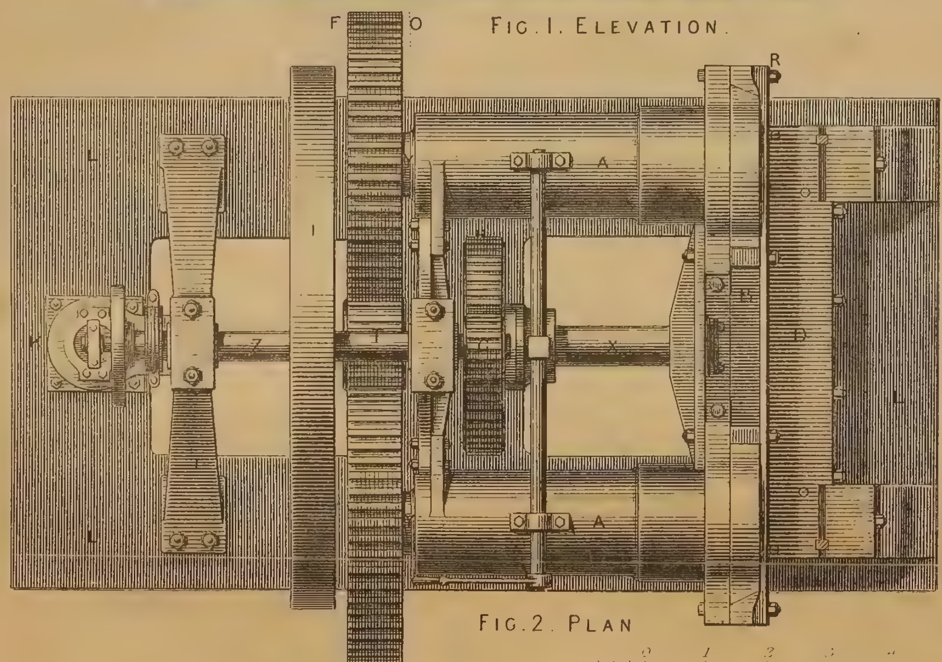


FIG. 2. PLAN

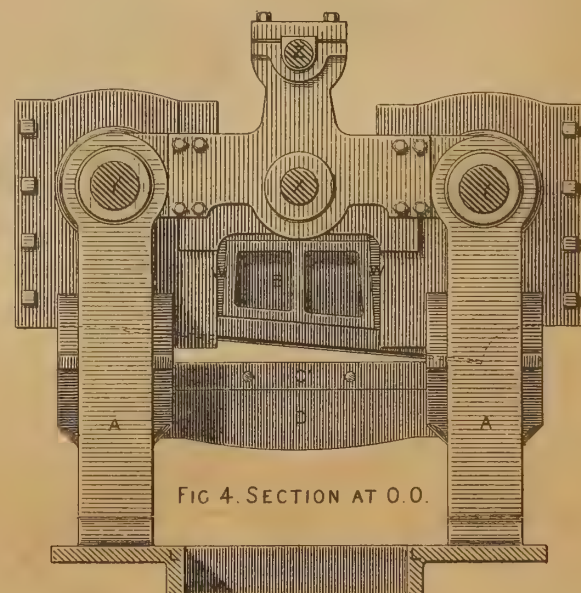


FIG 4. SECTION AT O.O.

0 1 2 3 4 5 10 FEET

W. Smith C.E. direx

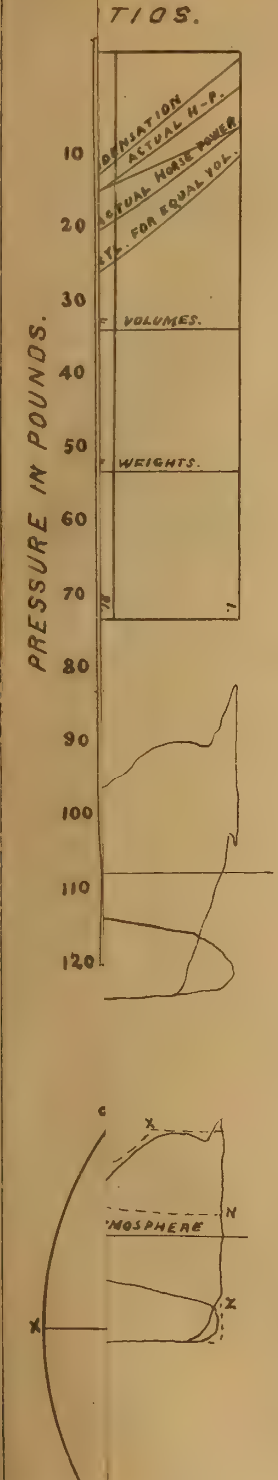


FIG. 5.

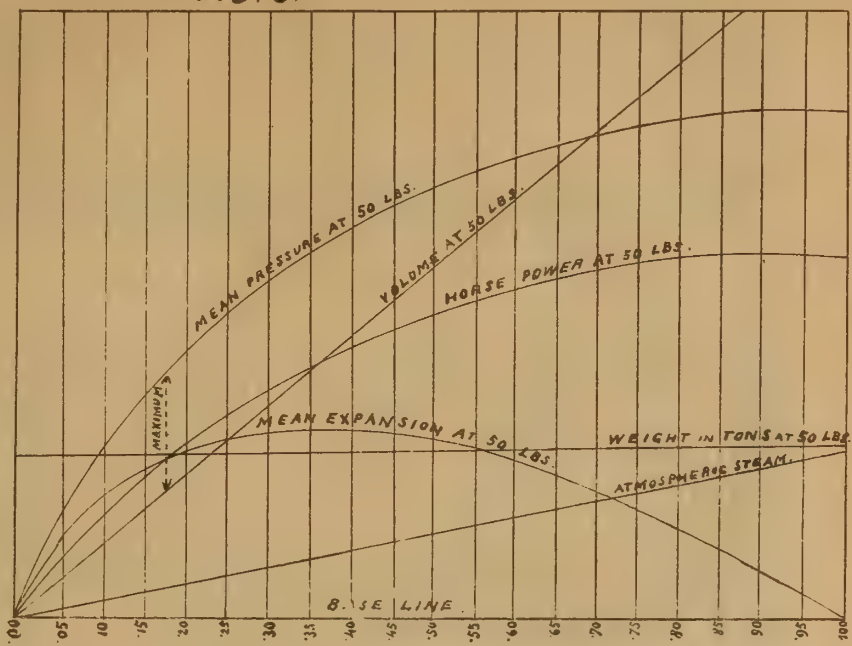


FIG. 4.

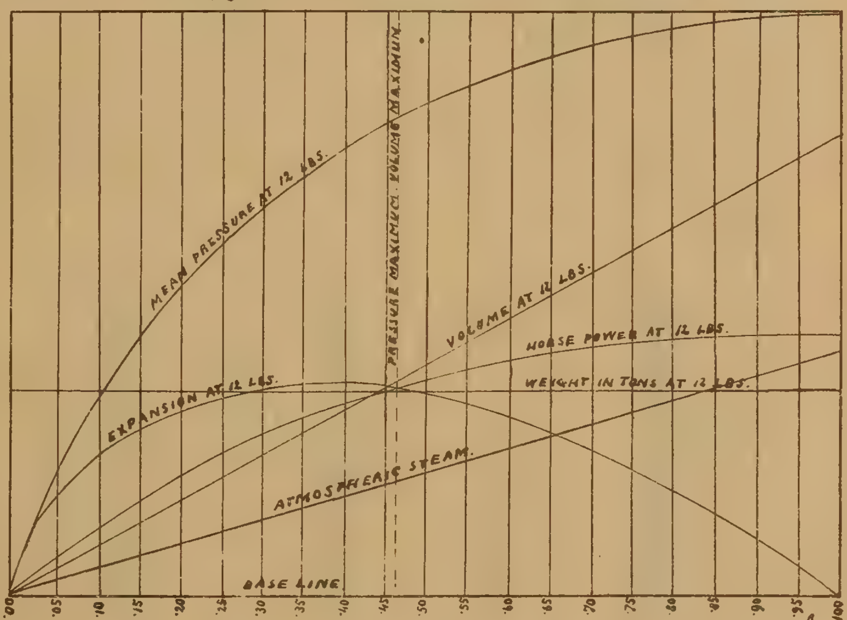
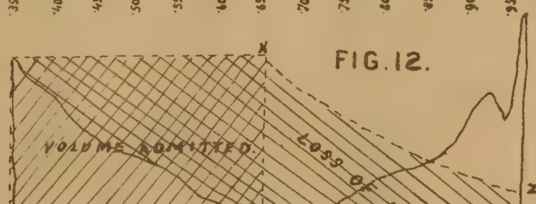
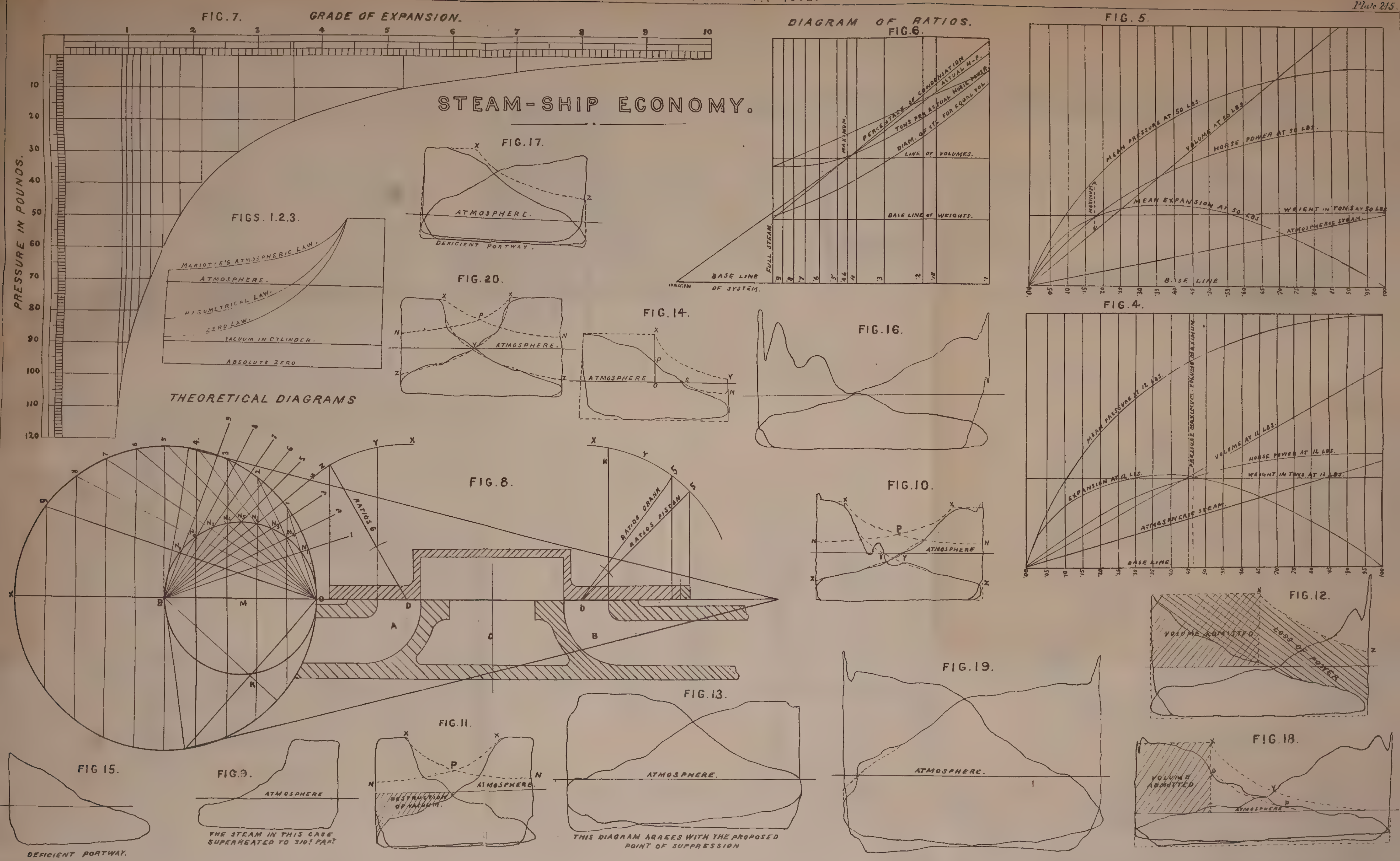


FIG. 12.





W. Smith, C.E. direx.

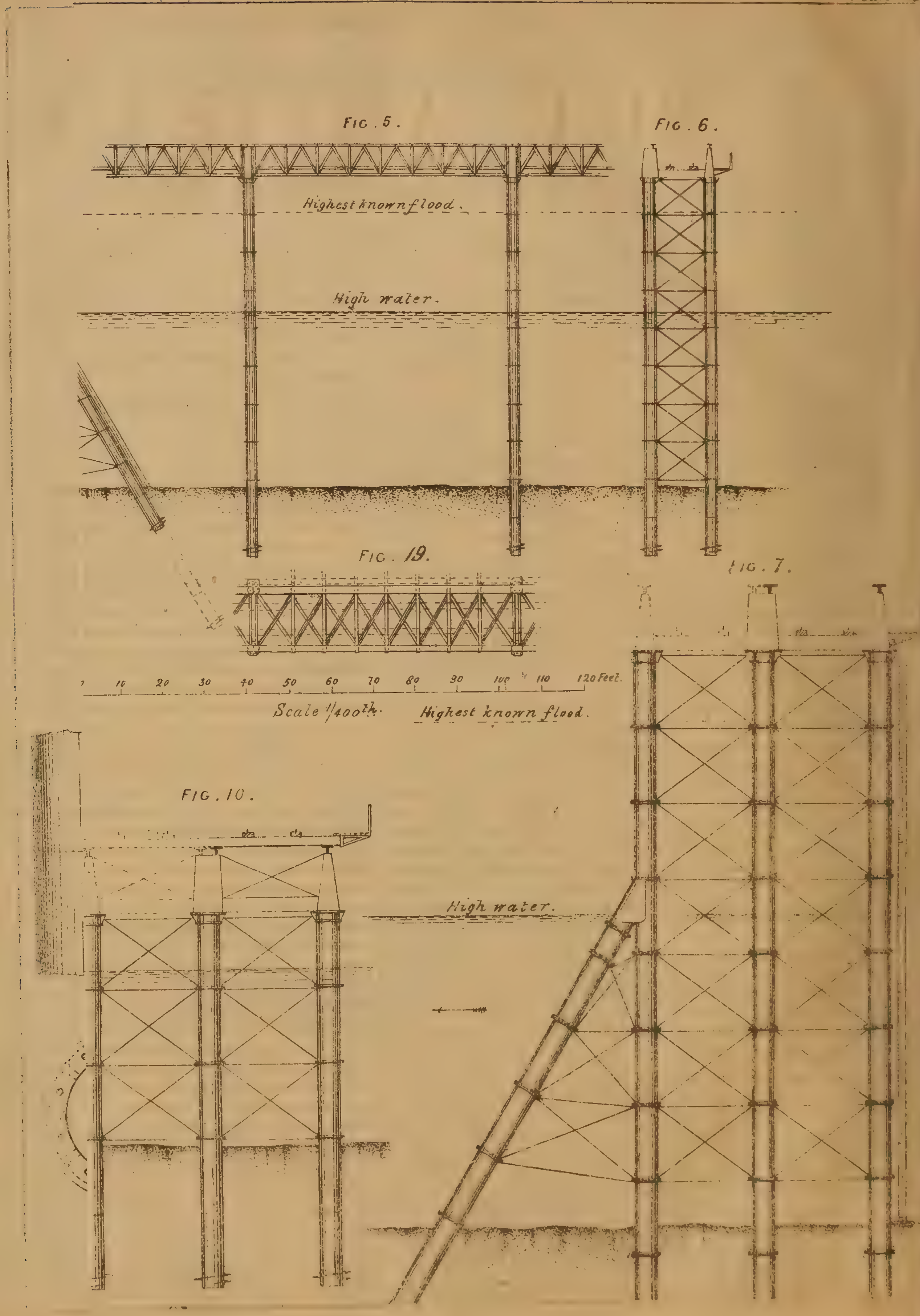


FIG. 5.
FIG. 6.
Highest known flood.
High water.
FIG. 19.
FIG. 7.
0 10 20 30 40 50 60 70 80 90 100 110 120 Feet.
Scale 1/400th.
Highest known flood.
FIG. 10.
High water.

THE ARTIZAN.

No. 234.—Vol. 20.—JUNE 1, 1862.

LARGE PLATE-SHEARING MACHINE.

Constructed by Messrs. J. Yule & Co., Glasgow.

(Illustrated by Plate 214.)

This machine is constructed to shear with ease, cold, boiler or boat plates 1¼in. thick. It is driven by a small steam cylinder, fixed upon the sole plate of the machine. The shear blades are 6ft. long, have a stroke of 6in., and make from 10 to 15 strokes or shears per minute. The headstocks or side frames stand upon a large sole plate, their centres 6ft. apart; the gap at the shears is full 2ft. deep, so that a plate 4ft. broad can be cut into two equal pieces; the clear distance betwixt the inner flanges of headstocks is 4ft., which will admit a plate 18ft. or 19ft. long by 4ft. wide to be cut in two plates of equal lengths. Each headstock contains a large malleable iron shaft, with eccentric ends for driving the slide holding the upper shear blade. The whole is self-contained, and requires no foundation except a levelled bed of brick or timber.

Fig. 1 is a side elevation of the machine; fig. 2, plan; fig. 3, elevation of the shearing end of the machine; fig. 4, transverse sectional elevation taken on the line O O. The same letters of reference in the several views denote the same parts of the machine.

A A headstocks; B slide holding upper shear blade C provided with adjustable guides W W; C lower shear blade; D stock for holding ditto; E gap or opening, 2ft. deep, to admit of the shearing of a plate 4ft. wide; F F the large driving spur wheels, fixed upon the eccentric shafts; G first driving pinion upon the end of the crank shaft, and working into the intermediate spur wheel H. The intermediate shaft upon which the wheel H is keyed, has also keyed upon it the large pinion T which drives the two spur wheels F F; I fly wheel; J framing supporting fly wheel shaft; K steam cylinder; L sole plate of the machine; M M eccentric pins upon end of the driving shafts Y Y; N N connecting rods working into recesses in the slide B, and driven by the eccentric pins M M; both pins being placed in the same position causes the slide to move up and down perfectly parallel; the slide is also guided at the ends with V shaped sides P P; these sides are bound together with the wrought iron bar R.

A SHORT CHAPTER ON THE SCREW STEAM NAVY.

There has been as yet no incident in connection with the great drama which is now being enacted on the American continent which has had such a thrilling effect on ourselves as the naval action fought at Norfolk, on the James's River, on Saturday and Sunday, the 8th and 9th of March last, between the *Merrimac* frigate, and the Federal fleet, including the *Monitor*.

This action has furnished our newspaper press with subjects for sensation leaders, and, in the absence of anything of a more exciting nature at home, the production and reproduction of these articles, presenting this action in every point of view, has produced an effect on the public mind which the facts of the case will not warrant, when these facts are carefully sifted and enquired into by those who are able fully to appreciate them.

In a very well-written article in one of the daily papers—written on receipt of the first intelligence of the result of the action—the writer says, "That not long ago, in a complaicent article about the maritime power of England, we congratulated our readers upon possessing a navy of one thousand ships of war. To day we are to warn them that the Queen of the Seas has only four ships afloat to maintain her proud and necessary supremacy. The balance has neither disappeared under the waves nor succumbed to an enemy, they have simply been snuffed out by the battle between the *Monitor* and the *Merrimac*."

We cannot entirely condemn the spirit in which this article was written, inasmuch as it gives expression to the deep interest taken by the nation in matters relating to the welfare of the Royal Navy. At the same time we do not think the attempt to get up another panic (naval), becoming the dignity of a great nation. Nor is it warranted by the facts of the case.

We propose to consider this battle between the *Monitor* and *Merrimac* from two very important points of view; first, as a question of engineering; second, looking at the reconstruction of the Royal Navy from a taxpayer's points of view.

As a contribution to science, this engagement has materially assisted in settling a question which has been warmly discussed since the first introduction of iron as a material for shipbuilding purposes, viz., its applicability for purposes of war.

In the year 1848 this question was first officially raised before a select committee of the House of Commons, on the Navy, Army, and Ordnance Estimates for that year. The committee was composed of the following well-known names:—Lord Seymour (now Duke of Somerset), First Lord of the Admiralty; Mr. Fox Maule, now Earl Dalhousie; Mr. Hume; Mr. George Banks; Sir James Graham; Marquis of Granby; Sir William Molesworth; Mr. Corry; Mr. Walter; Mr. Edward Ellice; Mr. William Miles; Mr. John Greene; Mr. Baring; Mr. Cobden, and Sir Thos. Acland.

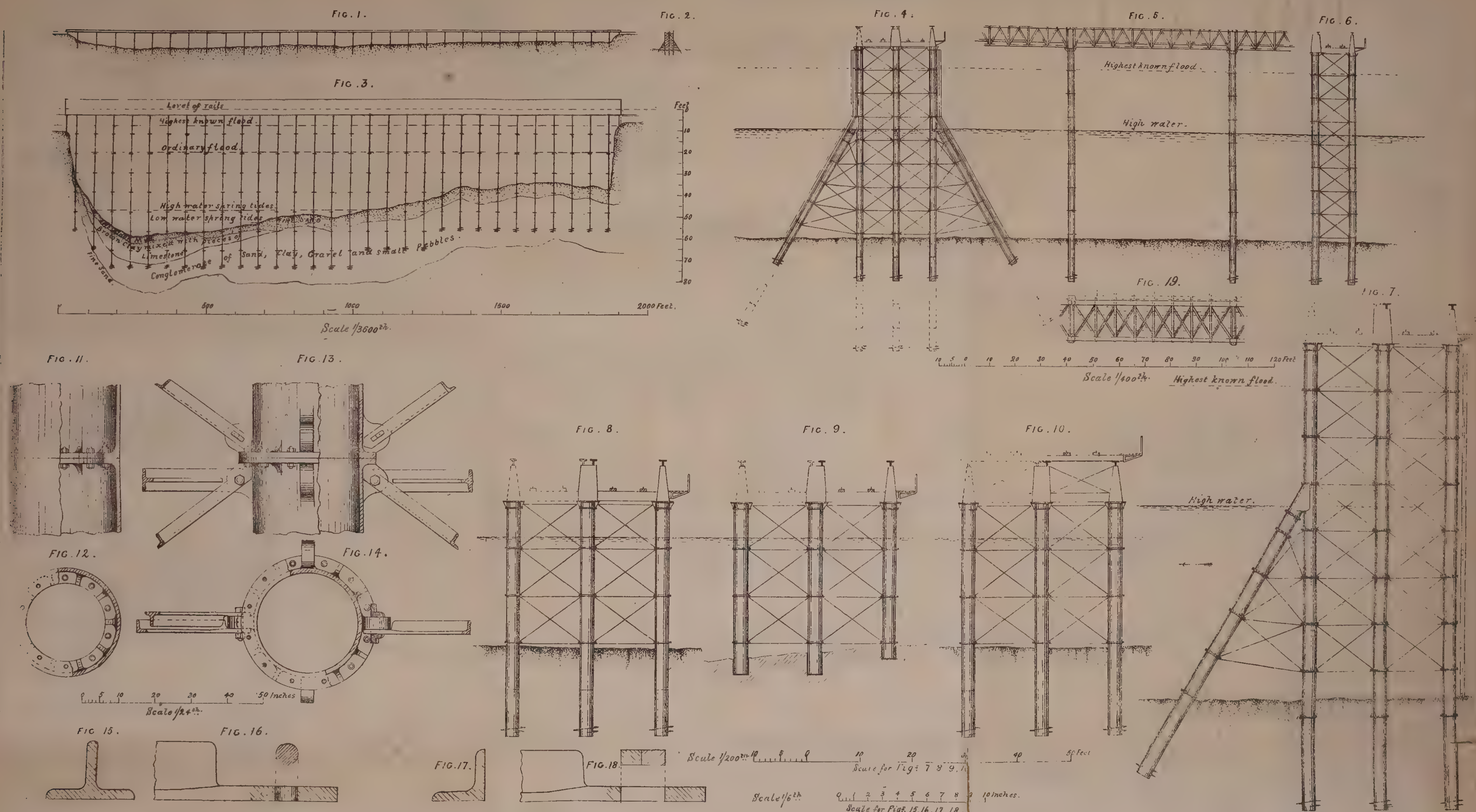
In the Report delivered to the House, dated July, 1848, the committee say, respecting a sum of £25,000 which appeared in the Navy Estimates for that year, for building iron steam vessels, "That it is a sum required to fulfil the contracts. The present Board of Admiralty have not ordered any iron steamers to be built as vessels of war, observing that most naval men regard such vessels with distrust. The Secretary of the Admiralty states that since the year 1844 the sum of £351,798 has been expended on iron steamers. From a return in the appendix it will be seen that there are above 30 iron steamers, either built or ordered to be built, for the public service. Many of these were intended for packets and tenders, others were designed for steamers of war. Five, namely, the *Simoon, Vulcan, Magaera, Greenock*, and *Birkenhead*, were ordered to be constructed of a large size, varying from 1300 to 1800 tons. The *Birkenhead* has been completed and fitted as a troop ship by the present Board of Admiralty, who distrust the use of iron in construction of war steamers, as also the *Simoon, Vulcan*, and *Magaera*, have been ordered to be fitted for the same service."

The committee further remark: "Your Committee cannot place any reliance upon the opinion expressed that further alterations will not shortly be deemed necessary; but they hope that the observations made upon former experiments will, for the future, induce greater caution in the application of public money." Again,

"Contradictory evidence has been given as to the applicability of iron to the construction of war steamers; your committee cannot, therefore, offer any satisfactory opinion upon this subject; but while so important a question was in abeyance, the expenditure of a large sum in the construction of iron steamers of war must be regarded as an inconsiderate outlay of money voted for the maintenance of the navy."

On reading over carefully the minutes of proceedings of the committee, we find that a very important amendment had been proposed, showing

INDIAN RAILWAY BRIDGES.



that the evidence had produced conviction on the minds of some of the members.

"Amendment proposed to leave out certain words, and insert the following. The evidence of the only officers examined by your committee who have commanded iron steam vessels under fire, viz., Captain Hall and Commander Charlewood, is unanimous in favour of their fitness for purposes of war, and the result of the experience of these officers was communicated to the late Board of Admiralty previous to iron steam vessels of war being ordered; on the other hand an experiment at Portsmouth was unfavourable. This experiment, however, appears to have been entirely insufficient on account of the weak and decayed state of the hull on which it was tried. Your committee cannot offer any satisfactory opinion upon this subject, but they recommend that no further expenditure shall be incurred on steamers of war until the question shall be conclusively set at rest by further experiments and experience."*

In reviewing the proceedings of the committee in regard to this matter, it would be easy to indulge in strong language setting forth the praises of Captains Hall and Charleswood, who, in spite of the strong professional feelings of their class did, at this early period, speak out their honest convictions of what they had seen and experienced. A little banter might also be indulged, inasmuch as the Admiralty, in the face of their own professional staff, stepped boldly forth and ordered the construction of the *Simoon*, *Vulcan*, and *Magaera* (iron frigates.) These are interesting memoranda, and, viewed in the light of our present experience, worthy of being had in remembrance.

But the full time had not then arrived; so great a change could not be so easily accomplished. The honest conviction of the majority of the committee, who, we doubt not, fairly represented the popular feelings, are expressed in the reproof which they, as guardians of the public purse, admininister to the Admiralty when they tell them that in the present circumstances of iron steamers of war, the expenditure of a large sum on their construction must be regarded as an inconsiderate outlay of public money. Since 1848 the public mind has been undergoing a change gradual, but sure; and the late naval battle fought on the American waters has ratified, in a very telling manner, our accumulating experience, and completely upset the professional prejudices of the whole naval service in favour of our wooden walls.

In examining more closely this action, the results are more complex than at first sight appears. The Confederate Commander Captain Buchanan, of the *Merrimac*, reports to his Government that he sank the *Cumberland*, captured and burnt the *Congress*, drove ashore the *Minesota*, and did other damage to some gun-boats. Now these results are entirely in accordance with our experience, and they are not surprising.

The *Congress* and *Cumberland* were floating batteries without steam power, and having a floating medium all round them, gave their attacking opponents the means of getting at their more vulnerable points; whereas the *Merrimac* with her coat of mail and her powerful beak, might, as regards the two frigates, have been without a single piece of artillery on board. Her coat of mail protected her from the fire of the frigates' batteries, while, with her attacking power, she drove in, with two blows, the wooden sides of the helpless vessels. In all this there is nothing wonderful; it is in accordance with the preconceived opinions of any naval man who has thought on this subject, and so convinced have all European naval powers become of the impotence and helplessness of sailing, as opposed to steam vessels of war, that the former have become entirely obsolete, except in the American service.

We could have wished that the *Congress* and *Cumberland* had been fitted with steam power, or that the *Merrimac* had been opposed by one of England's 90-gun wooden ships, such as the *Duncan* or *Renown*, with a propelling power of 12 knots an hour, having two 100 lbs. Armstrong guns on board. We believe that a concentrated broadside of 40 heavy guns with solid shot, fired at a moderate distance, would have injured her iron sides very materially.

Had the *Merrimac* in addition to her iron sides, been fitted with the necessary apparatus to throw Captain Norton's molten metal shells, we fully believe that no wooden vessel, possessing the heaviest battery, or the greatest power of locomotion (unless protected by iron plates of some description), would have lived before her.

We have seen the little gun-boat *Stork* fire three of these molten metal shells into an old frigate, and within an hour thereafter, the frigate was burning from stem to stern.

These projectiles are the most dangerous which can be used against a wooden structure, and no vessel can be safe or fit for active service unless plated over with such thickness of plates, as will break and effectually prevent the admission of these deadly shells. These plates need not be thick, say more than an inch or $1\frac{1}{4}$ inches, and can be fitted quickly and at a moderate expense.

The battering ram power of the *Merrimac* has been urged as an argument in favour of making this mode of warfare general. It is argued that our ships should lay aside their artillery, and be provided with long beaks and ponderous sides, and go tilt at their enemies. Unfortunately for this theory, both sides can play at this game. If belligerents could be coaxed into something like system in giving and then returning blows with their beaks, something might be said in favour of this form of warfare becoming general; but while one vessel is beaked and clad in the most approved fashion, she would have great difficulty in inflicting any injury to an enemy's ship of superior, equal, or even less propelling power, if well handled, though unprovided with beak power of attack or resistance.

In such cases stratagetic skill and bravery will then be brought into action, and will, as heretofore, gain the victory.

We come now to the more novel and exciting action between the *Merrimac* and *Monitor*, the former a large timber structure, covered over with iron plates. The latter an iron structure also protected with thick armour plates, having one of Captain Coles' Cupolas on deck also protected by iron plates five inches in thickness. In this Cupola Tower the *Monitor's* gun was placed, which did such good service to the Federal Government on that eventful morning. It is reported that both vessels pounded away at each other with their artillery for several hours. Then the *Merrimac* attempted to run down her opponent but was unsuccesful, when both vessels retired without victory crowning the efforts on either side.

It would be ungraceful not to offer a certain meed of praise to the designer of the *Monitor*, she was small, with a light draught of water, and carried only one, or at most two, guns, with these, however, she was able to keep at bay on opponent more powerful in speed, number of guns, and tonnage, but we cannot join in the unqualified approbation of this vessel; had the *Merrimac* posessed only one of those guns which was tried at Shoeburyness within one month of the day on which this action was fought, this gun would with one or two shots, have pounded the tower and destroyed the one and only means of offence and defence which the *Monitor* possessed and rendered her a mere mass of useless iron.

It would appear as if the officers and crew of the *Merrimac* had been somewhat puzzled at the novelty of their opponents, or they would very soon have suffocated every soul on board, it is reported that the *Monitor* was boarded once or twice, but no weak point was discovered to effect an entrance; had the crew of the *Merrimac* placed an old sail or a few pieces of coal box plate on the top of the *Monitor's* smoke pipe as the Americans are pleased to call their chimney, or had a live shell been dropped into this said smoke pipe, the chances would have been very much against the lengthened existence of this doughty little vessel of Captain Ericcson's.

Capt. Ericcson is well known in England, but his name has hitherto been associated with attempts to carry out the inventions of others. Some eighteen years ago we had the pleasure of inspecting the air engine, the joint invention of the Rev. Mr. Stirling and his brother, who was at that time the chief managing partner of the Dundee Foundry, Dundee. This engine was

* See pages 66 and 108 of the Report and Proceedings of the Select Committee on Navy, Army, and Ordnance Estimates 1848-9.

about twenty horse-power and worked with an accuracy and smoothness unsurpassed in any steam engine. Though the weak point (viz., the rapid and constant destruction of the air heaters) was easily discovered by any professional man.

Soon after we had seen this engine rumours reached England from America of the wonderful invention of Ericcsons Air Engine which was to supersede steam, and introduce a new era in steam navigation, Its un-glorious end need hardly be noticed. Ericcsons fruitless attempts with the screw propeller are also well known in England; in like manner the most striking feature of his *Monitor* is the adoption of Captain Cole's Cupola Tower.

With regard to this famed novelty of Captain Cole's we cannot see that its peculiarities are so striking or its advantages so allconvincing as to warrant the immediate reconstruction of our own Navy.

In the plan, as embodied in the *Monitor*, the gun was placed in a tower having vertical sides 9ft. above the deck; with the Armstrong gun already referred to, this tower would have pounded, and shivered in a thousand pieces had it been fifteen inches thick instead of five.

It may appear treasonable to question the favourite mode of the day, as Captain Cole's plan may be termed. We cannot even yet see the advantage of depriving all our noble ships of the means of delivering a heavy broadside fire. If, however, it be found advisable to have a class of ships to carry only a few tremendous eight or ten ton guns, capable of throwing, at great distances, ponderous projectiles, urged by 50lb. or more of powder, we do not see the very great advantage of a vessel of this description having three or six separate small towers. We would prefer placing our guns under one single roof, where space and ventilation would be more attainable. Neither do we approve of his railway turn table; it is too delicate in its machinery for the wear and tear of actual warfare.

To sum up our conclusions respecting this famous American fight, we remark that the iron-clad steam propelled vessel, the *Merrimac*, was like a giant amongst pigmies, when opposed to wooden structures having neither steam-power nor a coat of iron mail.

As regards the struggle between the *Monitor* and *Merrimac*, nothing decisive has been proved, except that both vessels were deficient in power of artillery and weight of projectile; hence we are as far as ever from a settlement of the question, what is the proper thickness of plate wherewith to arm our ships of war. Neither can this be settled till our Armstrongs have confessed that they have reached the utmost limit of the strength of wrought iron, and the power of gunpowder to urge the ponderous projectiles. There is one other feature common to both vessels, viz., that they were extemporized for a given emergency, and totally unfitted to bear the ordinary risks of the sea. This was more especially the case with the *Monitor*, whose powers of locomotion and sea enduring properties were so meagre, that her safe arrival at the scene of action was looked on by the good people of New York as something miraculous.

One other last inference we would draw from this fight is, that the novel features of both *Merrimac* and *Monitor* are mere plagiarisms on the costly experiments which have been carried on in England during the past six or eight years. We do not grudge our American cousins the application of our knowledge, obtained as that has been at so great a cost, as the practical illustration carried out by them bring home conviction in such a way that no amount of money spent at the practice-ground at Shoeburyness, or the *Excellent* at Portsmouth, could have accomplished; and they have solved some knotty problems, which could not have been otherwise demonstrated.

But this memorable action has thrown no new light on the all important question of the reconstruction of the British navy. Whether our ships should be iron plates on a purely iron structure, or iron plates on wooden bottoms, or the new class of ships suitable to defend our harbours, to fight our battles on the seas surrounding our island home, or the ships suitable for the important duties of defending and protecting our immense colonial possessions as well as our mercantile navy, whose ships are to be found on every sea. We say that these problems are yet unsolved.

In examining this subject from a tax-paying point of view, we would again refer to the excitement caused by the first report of this action. It not only excited the newspaper press, and their millions of readers, but it found expression in both Houses of Parliament; and the government were so acted on by the screw of public opinion, as within a very few days after the arrival of the news, as at once to suspend all works on timber ships, and to order the conversion of one of the finest line of battle-ships of our navy (viz., the *Royal Sovereign*), into an iron clad frigate, with Captain Cole's towers, &c.

We have no wish to dogmatise, or rashly to condemn the goverment for yielding to a popular demand, but we do think that though it has been demonstrated that some change must take place, we protest that a great deal has yet to be proved before that change can be fairly entered into.

We would ask wherein lies the secret springs of this demand for change? Does it arise from sensation leaders in the metropolitan newspaper press? From members of parliament who seek to convert the floor of the House of Commons into a lecture room? Or is it from the very powerful and growing influence of schemers, inventors, and manufacturers, whose several crafts will be enriched by extensive changes consequent on the reconstruction of the British Navy?

Again we ask, why should we be dragged hastily into such momentuous changes, and heavier burdens be laid on the shoulders of the tax-payers? The changes indicated are all in favour of Britain; she has an unlimited supply of iron, the greatest number and the most ingenious workers in iron which the world has ever seen; and more even than these, she has that which forms the real sinews of war, namely, wealth. Money, we had almost said, in unlimited abundance, were that wealth and resources really required for defending the honour of our country, either at home or abroad.

The work of reconstruction is proceeding most satisfactorily. The *Warrior*, *Black Prince*, *Defence*, and *Resistance* are all ready for active service, and either of them would have been more than a match for anything we have heard of in the American waters.

Without fear of contradiction we would assert that the navy of Britain, as it exists in this present month of May, 1862, is far more formidable than is generally known; its tremendous material power can only be duly appreciated by professional men, who can compare its present condition with its early history, or even with the very latest lessons sent to us from the shores of the American continent.

To grumble and find fault with every branch of the executive, is the birthright of every Briton. In order that we make sure that we have good and sound reason for another growl, and experience the pleasures of another 1*d*. or 2*d*. added to the income tax, we will pass in review, what, amongst many other things, has been accomplished during the past forty years.

Whether the government has been in the hands of either the two great parties who hold the reins of state, there have been changes and improvements carried out, which have placed the material of our navy in a position that will challenge the most rigid enquiry, and bear the test of actual war.

We will pass in review some of the changes just mentioned. In 1782, James Watt obtained letters patent for his improvements in steam engines. In 1788, Mr. Miller, a Scotch gentleman, first applied the steam engine to navigation. In 1812, steam vessels were first employed on the Clyde, to carry passengers. In 1815, this invention reached the Thames. In 1818, Mr. David Napier, of Glasgow, established steam communication between Greenock and Belfast. Thus fairly establishing the practicability of ocean steam navigation.

It would be useless to attempt to follow step by step the magnificent strides which have been made in ocean steam navigation by our mercantile marines, or to attempt a contrast between David Napier' *Rob Roy*, of 90 tons burden, with a 30 horse-power engine, with the splendid vessels of three and four thousand tons burden and a 1000 horse-power, which trade out of the Ports of London, Liverpool, Southampton, and Glasgow, for America, India, and Australia, &c.

From the contemplation of the progress made in the mercantile marine, of which Britain may well be proud, we turn to the Royal Navy, and find that the *Comet* was the first vessel constructed in the public service in 1822, since that time the progress made has been such as to amount to a complete revolution in every class of vessel composing our fleets.

It would be unfair to pass over unnoticed the fleet of valuable and useful paddle-wheel vessels without remarking that they have done good service to their country in every part of the world, and pass to the consideration of our screw steam ships.

The introduction of the screw propeller gave a new feature to our ships of war, and soon brought home the conviction to the minds of the most prejudiced naval man that the old sailing ship could not compete with almost any class of ship having steam as a motive power, and the submerged screw as a propeller.

This is not the place, nor do we deem it necessary to go into the question of priority of claim as to who was the first to introduce the screw.

It was not a new invention; it is as old as Archimedes, and had often been suggested in undeveloped schemes.

We give the credit to Francis Petit Smith for his energy and perseverance in making it a practical reality. He took out his patent in May, 1836. In 1840 the Admiralty commenced their experiments; in 1842-3 the *Bee* and *Rattler*, the pioneers of our screw navy, were constructed.

We think it unnecessary in passing in review our earlier efforts, to do more than express a regret that the Surveyor of the Navy of that period should have obstinately closed his eyes to its value, and, for a brief period, retarded its introduction; such men are to be found in every walk of life, in private professions as well as in the public service.

From 1843 to 1853 we went on, step by step, gaining experience, feeling the way, and then taking greater aims. In 1847 four line-of-battle ships were converted into screw steam ships, and in 1853 the *Duke of Wellington* was fitted and fully equipped for sea. Her success was complete.

The Russian War, the operations in the Baltic and Black Seas followed, and the work of reconstruction went on with giant strides. From that period, viz., 1853 down to last month, an amount of energy, skill, and money have been expended on our fleets that have never been witnessed in the annals of any nation. The results are worthy of the greatest naval power in the world. The following tables will fully bear out our remarks:—

	Number of Guns in each Ship.	Number of Ships of each Class.	Tons.	Horse-power.	Total number of Guns in each Class.	Estimated Cost of Ships fitted for Sea.	Estimated Cost of Engines and Machinery.
Line-of-Battle Ships	131	4	15,531	5,100	524	—	—
	121	3	12,098	2,500	363	—	—
	100	1	3,101	500	100	—	—
	99	4	13,901	3,000	396	—	—
	90	20	65,973	13,350	1,800	—	—
	86	14	40,292	6,500	1,204	—	—
	80	12	31,084	4,800	960	—	—
	82	1	3,240	500	82	—	—
	70	2	5,239	900	140	—	—
Total	....	61	190,459	37,150	5,569	£5,580,794	£2,004,250
Frigates	51	27	76,092	14,160	1,371	—	—
	50	1	3,740	1,000	50	—	—
	47	1	1,872	360	47	—	—
	40	1	3,733	1,000	40	—	—
	36	6	14,172	3,000	216	—	—
	32	4	8,112	2,530	128	—	—
	26	3	7,988	1,910	78	—	—
Total	....	43	115,709	23,960	1,930	£3,099,320	£1,207,550
Corvettes and other smaller vessels	22	8	13,399	3,100	176	—	—
	21	16	23,973	6,100	336	—	—
	20	2	2,592	500	40	—	—
	17	17	24,050	2,860	289	—	—
	14	4	4,038	1,110	56	—	—
	11	11	6,713	1,560	121	—	—
	9	4	1,944	240	36	—	—
	7	3	3,521	1,000	21	—	—
	6	11	9,783	2,650	66	—	—
	5	21	8,845	1,700	105	—	—
	4	32	20,878	5,730	128	—	—
	1	4	1,201	320	4	—	—
Total	....	133	121,937	26,770	1,378	£2,902,221	£1,371,750

	Horse-power in each Gunboat.	Number of Boats in Each Class.	Tons.	Horse Power.	Total number of Guns in each Class.	Estimated Cost of Gunboats fitted for Sea.	Estimated Cost of Engines and Machinery.
Gunboats carrying Two Guns each	60	139	37,530	8,340	278	—	—
	40	12	2,784	480	24	—	—
	20	20	4,220	400	40	—	—
Total	...	171	44,534	9,220	342	£1,103,350	£461,000

	Number of Guns in each Ship.	Number of Ships in each Class.	Tons.	Horse-power.	Total Number of Guns in each Class.	Estimated Cost of New Ships and Alterations to old ones.	Estimated Cost of Engines and Machinery.
Block Ships	60	7	12,515	2,400	420	—	—
	12	4	4,807	800	48	—	
Floating Batteries	16	4	11,979	1,250	106	—	—
	14	3					—
Total	...	18	29,301	4,450	574	£674,265	£196,300
Iron Frigates (complete)	40	2	12,148	2,500	80	—	—
	18	2	7,336	1,200	36	—	—
Total	...	4	19,484	3,700	116	£875,780	£203,500
Iron Frigates (building)	50	3	19,863	3,750	150	—	—
	32	2	8,126	1,600	64	—	—
Total	...	5	27,989	5,350	214	£1,259,505	£294,250
Wood Ships (Frigates), Iron-cased (nearly complete)	50	5	20,225	4,400	250	£910,125	£242,000

SUMMARY.

	Number of Ships of Each Class.	Tons.	Horse-power.	Total Number of Guns in each Class.	Estimated Cost of Ships fitted for Sea.	Estimated cost of Engines and Machinery.	Total Estimated Cost.
					£	£	£
Line-of-Battle Ships	61	190,459	37,150	5,569	5,580,794	2,004,250	7,585,044
Frigates	43	115,709	23,960	1,930	3,099,320	1,207,550	4,306,870
Corvettes and other Smaller Vessels	133	121,937	26,770	1,378	2,902,221	1,371,750	4,273,971
Gunboats	171	44,534	9,220	342	1,103,350	461,000	1,564,350
Harbour Defence Vessels	18	29,300	4,450	574	674,265	196,300	870,565
Iron Ships (complete)	4	19,484	3,700	116	875,780	203,500	1,079,280
Iron Ships (building)	5	27,989	5,350	214	1,259,505	294,250	1,553,755
Wood Ships, Iron-cased (nearly complete)	5	20,225	4,400	250	910 125	242,000	1,152,125
Grand total	449	569,637	115,000	10,373	16,405,360	5,980,600	22,385,960

The facts in these tables may be briefly summed up as follows:—The steam screw fleet of Britain consists of 440 vessels, carrying an armament of 10,373 guns. The tonnage, 569,637 tons, propelled by 115,000 horses, or, what is nearer the truth, by 460,000 indicated or actual horse power, the estimated cost of which is £22,385,960.

The above are worthy of the maturest consideration, when we reflect that this mighty fleet has been created by the skill, energy, and wealth of Britain in a little more than nine years. We would, therefore, depreciate the attempt to get up another reconstruction panic, founded on the engagements of the *Merrimac* and *Monitor*.

All that we ask for is that the changes in the material of our fleets shall not be precipitated by either one party or another; neither by Captain Coles, with his towers and turn-table, who, flushed with an accidental success, has got the public ear by means of certain organs of the public press, nor by the representative of a professional clique, whose assurance is only equalled by their wordy utterances.

We have no desire, if we had the ability, to rise from the consideration of ships and guns—such grossly material objects—to discuss the higher questions of State policy, to enlarge on the glory, the honour, and prestige of Britain.

We believe that her prestige, and power, and glory are intimately associated with the history of her navy, and we do not think that the tax-payer would grudge any reasonable amount of money to sustain the navy and the maritime power of England, and her position as first among the nations of the earth.

But to yield hastily to a panic got up by interested parties, and again enter on that which will lead to an expenditure of some thirty millions of money, until science has fairly settled some of the most difficult questions ever presented for solution, would neither be for the welfare nor dignity of this nation.

ON THE STABILITY OF FAIRBAIRN'S TUBULAR WROUGHT IRON CRANES. (*Illustrated.*)

By J. J. Birckel.

The following will, we think, form an interesting theorem in applied mechanics, as being complementary to the general theorem of resistance of beams to transverse strains:—

In order to obtain a clear knowledge of the work of resistance of the structure of the crane illustrated by Fig. 1 we will first reduce it to the elementary shape out of which we may say that it has risen, a crane illustrated by Fig. 2, and consisting of an upright pillar, firmly fixed into some adequate foundation, and of a jib well secured to the pillar, projecting upward in an oblique direction.

In order to the stability of this crane two things are requisite, viz: first, that the upright pillar be able to resist the action of the weight W, and secondly that the oblique jib be able to resist the action of the same weight.

First then: The pillar has to resist a crushing pressure equal to W; this needs no demonstration. But in consequence of the weight being applied at a distance A B from the centre line of the pillar, this latter has also to resist a bending moment which we shall define by the following considerations: The conditions of the present problem will not be altered if we suppose the pillar to be produced up to the point A, and acted upon at that point by an oblique pressure W_2, which will resolve itself into two components W and W_1 respectively vertical and horizontal, and if we construct the parallelogram A B F C, A F will represent the pressure W_2, A B the component W_1, and A C the component W. Let M be the bending moment at the point C, then we have

$$M = W_1 \times AC$$

but we have also $\quad W : W_1 :: AC : AB$

whence $\quad W \times AB = W_1 \times AC$

and $\quad M = W \times AB$

Secondly: In order to define the action of the weight W upon the oblique jib let us resolve W into two components W_3 and W_4 respectively, normal and paralled to the jib; if we produce the parallelogram B G E D where B E is made to represent W, B D and B G respectively represent the components W_3 and W_4; this latter is the crushing pressure along the jib and if M_1 be the bending moment at the point G, then

$$M_1 = W_3 \times BG$$

but by reason of the similitude of the triangles B H G and B D E we have the proportion

$$BG : GH :: BE : BD$$

and we have also the proportion

$$W : W_3 :: BE : BD$$

whence by substitution

$$W : W_3 :: BG : GH$$

hence $\quad W \times GH \; W_3 \times BG$

and $\quad M_1 = W \times GH = W \times AB$

but we have demonstrated also that

$$M = W \times AB$$

therefore $\quad M = M_1$

This is an important point in the present investigation, for it shows us that the strength of the jib at the point G for resistance to the component transverse strain of the weight W must be equal to the strength of the pillar at the point C for resistance to the same strain. If this statement be correct we must be able to demonstrate that the compound structure of this crane is acted upon between the points C and G by a couple of the intensity W × A B, and we must be able to define that couple.

In order to do this, we will suppose that the pillar is produced to the point A and that a horizontal tension rod connects the points A and B of the pillar and jib (fig. 4); for it is evident that the portion C G of the structure of this crane is subject for its stability to the same law as the portion C G of the structure illustrated by Fig. 2. Let us construct the parallelogram A B H G; if B H be made to represent W, A B will represent the strain W_5 on the tension rod and B G the compression strain W_6 on the jib, which here is only a strut. This strain W_6 at the point G, where it is communicated to the pillar, resolves itself again into its components W_7 and W_8; the latter W_8, equal and parallel to W is the crushing pressure, and W_7 is equal and paralled to W_5, but acts in an opposite direction; the pressures W_5 and W_7 form the couple which we desired to define; its intensity is $W_5 \times AG$ and if Mx be the bending moment at any point x between the points C and G we shall have

$$Mx = W_5 \times (Ax - Gx) = W_5 \times AG$$

but we have the proportion

$$W_5 : AB :: W : AG$$

whence $\quad W_5 \times AG = W \times AB$

and therefore $\quad Mx = W \times AB$

Hence follows this general law:—

When a straight bar or pillar, firmly fixed to an immovable foundation, is acted upon at a normal distance l from its centre line by a pressure W paralled to that centre line, that bar has to resist a bending couple of the intensity W l in the whole portion of its length between the points of application of the pressure W and of its connection with the foundation; it is evident that the bar becomes a strut when the direction of W is towards the foundation, and a tie when that direction is from the foundation.

Let us now pass to the crane with single jib constructed in the shape of an arc of a circle, as illustrated by Figs. 1 and 3, and let us assimilate the foregoing conclusions to this particular case. Let W be the weight suspended at the extremity of the jib and let M be the bending moment at the point C; similar considerations to those previously made will show that the vertical portion of the jib is subject to a crushing pressure W, and that the bending moment at the point C is

$$M = W_1 \times AC = W \times AB$$

But we will now define the action of the weight W upon an elementary portion of the arc of the jib, at the point D for instance, and to simplify the matter we will suppose the centre of the arc of the jib to be a point O in the vertical passing through the centre of gravity of the weight W. The element of the jib at the point D is nothing but the lower portion of a beam projecting, at that point, in a direction tangent to the curvature of the crane and we must deal with it as we have dealt with the jib illustrated by Fig. 2. If therefore we produce the tangent D I and construct the parallelogram O D I E, if O I be made to represent the pressure W, its components W_3 and W_4 respectively will be represented by the lin E I and D I. W_4 is the crushing pressure and if M be the bending moment at the point D we shall have.

$$M_1 = W_3 \times DI$$

but by virtue of the similitude of the triangles O E I and D H I we have the proportion

$$OI : EI :: DI : DH$$

and we have also the proportion

$$W : W_3 :: OI : EI$$

whence by substitution

$$W : W_3 :: DI : DH$$

and $\quad W_3 \times DI = W \times DH$

If α be the angle which the radius O D makes with the horizontal O G and if R be that radius, this last equation may be rendered in the form

$$M_1 = W R \cos \alpha$$

which equation holds good for any value of the angle α

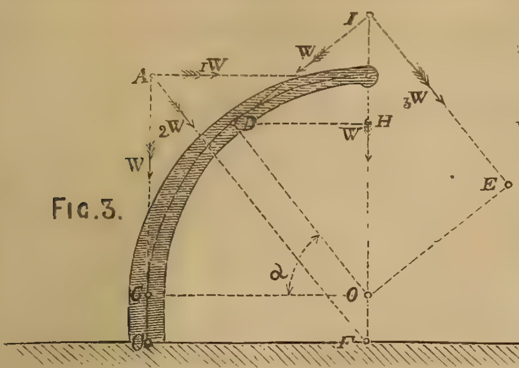


FIG. 3.

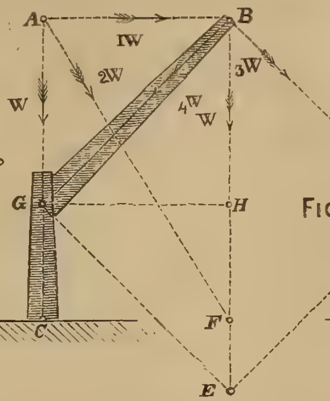


FIG. 2

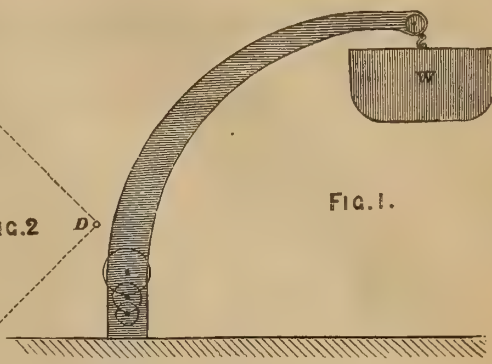


FIG. 1.

Let $\alpha = 0$

then $\cos \alpha = 1$

and $M_1 = W.R = W \times A B.$

Here therefore we are again met by the fact that the transverse section at the point G, must be equal to the transverse section at the point C. Let us remember here that the jib is constructed in the shape of a tube; if a and a_1 be respectively the compression and the tension flanges, and d the depth at any angle α, the moment of inertia at that section will be for each flange respectively

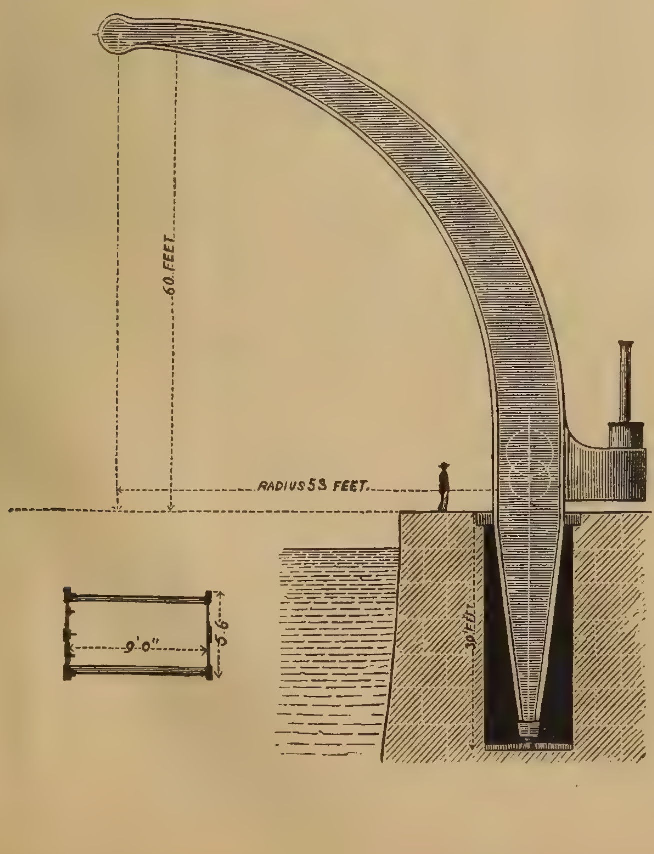
$$a_1 \frac{d^2}{4} \text{ and } a \frac{d^2}{4}$$

If each flange is to do one half the work and the unit strain upon each to be S_1 the respective areas will be found by the formula

$$a_1 = \frac{W \cos. \alpha}{S_1} \left(\frac{R}{d} - \frac{1}{2} \right)$$

And

$$a = \frac{W \cos. \alpha}{S^1} \left(\frac{R}{d} + \frac{1}{2} \right)$$



Should the question be proposed to define the neutral axis, if z be its distance from the line drawn through the centres of gravity at various sections of the jib, the quantity $z\ a_1$ will be determined by the formula

$$z = \frac{I W \cos. \alpha}{(a + a_1) W R \cos. \alpha} = \frac{d^2}{4 R}$$

It is evident that $z\ a$ in the present case will be on the tension side.

From the preceding investigation we are enabled to draw the following conclusion, viz.: That the jib of the crane under consideration follows the law of stability of a cantilever whose length is equal to the horizontal projection of the jib.

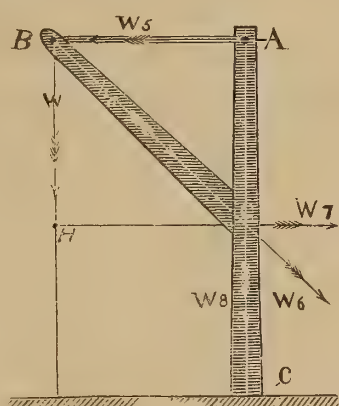


FIG. 4.

We may here state that Mr. Fairbairn had asserted this truth in his lecture on these cranes before the Institution of Mechanical Engineers at Newcastle in 1857; but we have deemed it proper to demonstrate the same, on the ground that whenever a scientific truth, however palpable it may be, admits of a demonstration, that demonstration ought to be set forth; for while this is not done, the said truth is accepted as an axiom, and the axioms on which any science is based ought to be as few as possible.

From the foregoing investigation we may infer also that this structure offers all the guarantees of strength and stability of a straight box girder, and it remains for us to show whether practice corroborates this conclusion drawn from purely theoretical considerations. Subjoined are the results of experiments made upon a batch of six cranes fixed at the Dockyards of Keyham and Devonport. These were, each in its turn, tested by a succession of loads with a view to ascertain the deflection under each load; they were of the nominal strength of twenty tons with a reach of 32ft. 6in. and a clear height of 30 feet above ground.

Load.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	in.	in.	in.	in.		
2 tons	0·32	0·31	0·37	0·25	0·27	0·31
5 „	0·90	0·87	0·87	0·75	0·88	0·86
10 „	1·77	1·77	1·75	1·62	1·62	1·76
15 „	2·80	2·83	2·69	2·56	2·65	2·31
20 „	3·97	3·92	3·56	3.56	3·62	3·75
Permanent set for 40 tons.	0·64	0·62	0·40	0·62	0·44	0·50

These figures show that practically speaking the deflections are proportional to the weights, a result which we always look for in a straight girder.

STRENGTH OF MATERIALS.

DEDUCED FROM THE LATEST EXPERIMENTS OF BARLOW, BUCHANAN, FAIRBAIRN, HODGKINSON, STEPHENSON, MAJOR WADE, U.S. ORDNANCE CORPS, AND OTHERS.—BY CHARLES H. HASWELL, C.E.

(*Continued from page* 104.)

RESULTS OF EXPERIMENTS ON THE STRENGTH AND DEFLECTION OF WROUGHT IRON RAILS (BARLOW).

Rails.	Weight per yard.	Length of bearing.	Depth.	Area.	Weight.	Deflection. For Weight.	Deflection. For each ton.
	lbs.	Feet.	Inch.	Inch.	lbs.	Inch.	Inch.
 Flanges, 2·25; rib, ·65	60	2·75	4·5	6·166	2240	·027	—
	60	2·75	4·5	6·166	4480	·031	·004
	60	2·75	4·5	6·166	17920	·057	·005
	60	2·75	4·5	6·166	26680	·087	·010
,, Flanges, 2·6 × 1·25 ins.; rib, ·85	75	4·5	5·	7·5	4480	·050	—
	75	4·5	5·	7·5	20160†	·165	·023
 Flanges, 3·5 × ·6in.; rib, ·8 ...	57	2·75	3·5	5·85	4480	·050	—
	57	2·75	3·5	5·85	17920†	·152	·039
 * Head, 2·25 × 1 in.; rib, ·75; flange, 3·5 × ·8...............	60	2·75	4·	6·7	4480	·034‡	—
	60	2·75	4·	6·7	17920	·064	·082
 Head, 2·5 × ·6 in.; rib, ·6; Bottom, 1·25 × ·88	51	3·	4·5	5·55	6720§	·024	—

* Equivalent dimensions. † Destructive weight.

‡ The deflection between this and a like bar to this, reversed, was, for between 5 and 10 tons weight, as ·0074 and ·0059. § Destructive weight 7 tons.

MEAN RESULTS OF EXPERIMENTS ON THE DEFLECTION OF A PAIR OF BARS BY THE TRANSIT OF A LOAD AT DIFFERENT VELOCITIES. (Rep. Comms. on Railway Structures.)

CAST IRON.

LENGTH BETWEEN THE SUPPORTS 9 FEET.

Velocity.	Depth.	Breadth.	Weight of load.	Deflection.	Set.	Breaking weight.
	Inch.	Inch.	lbs.	Inch.	Inch.	lbs.
At rest	2·	1	1120	·87	·24	—
	....	....	2242	4·41	1·43	2256
	3·	1	1120	·35	·08	4235
15 feet per second	2·	1	1120	1·39	·21	1842
	3·	1	1120	·38	·07	3400
24 ,, ,, ...	2·	1	1120	1·48	·15	1520
	....	....	1496	3·94	1·07	1524
29 ,, ,, ...	2·	1	1120	2·28	·20	1216
33 ,, ,, ...	2·	1	1120	2·32	·36	1213
36 ,, ,, ...	2·	1	1120	2·31	·21	1176
43 ,, ,, ...	3·	1	1120	·45	·05	2182
LENGTH BETWEEN THE SUPPORTS 13 FEET 6 INCHES.						
At rest	3·	1	1120	1·35	·20	3124
43 feet per second	3·	1	1120	2·68	·26	1516
WROUGHT IRON.						
LENGTH BETWEEN THE SUPPORTS 9 FEET.						
At rest	3·	1	1120	·15	....	—
	3·	1	1778	·31	....	—
15 feet per second	3·	1	1778	·38	....	—
29 ,, ,, ...	3·	1	1778	·50	....	—
36 ,, ,, ...	3·	1	1778	·62	....	—
43 ,, ,, ...	3·	1	1778	·46	....	—
STEEL.						
LENGTH BETWEEN THE SUPPORTS 2 FEET 3 INCHES.						
At rest	·25	2	1120	·70	....	—
15 feet per second	·25	2	1120	1·02	....	—
29 ,, ,, ...	·25	2	1120	1·46	....	—

Mean Results of Experiments to ascertain the Deflections of Bars, Beams, &c., when the Load is suddenly applied, but without Impact. (Rep. Comms. on Railway Structures.)

CAST IRON.

Length between the Supports 9 Feet.

Depth.	Breadth.	Weight.	Deflection and Set. Load applied. Gently.		Suddenly.		Breaking Weight.
inch.	inch.	lbs.	inch.	inch.	inch.	inch.	lbs.
2·	1	448	1·24	·19	2·05	·43	602
3·	1	784	·59	·06	1·08	·13	1231
1·5	4	784	1·28	·10	2·26	·24	1053

As it is impracticable to give any general rule for the deflection of bars, beams, &c., of different lengths and sections, and when an experiment cannot be made to obtain the deflection in a particular case, reference must be had to the results of previous experiments upon bars, beams, &c., of a like character to that or those for which the deflection is required.

Thus, in the preceding tables (page 102 to 104) are given the deflections ascertained in very many cases, added to which is given a value or constant, obtained by the formula,

$$\frac{l^3\,W}{16\,b\,d^3\,D}$$

l representing the length in feet, D the deflection, and b and d the breadth and depth in inches.

In the first and second examples of the table are results of two experiments with a like material, but of differing dimensions.

In order, then, to determine the relative values of the constants, the varying elements of the case must be reduced to an uniform measure.

In the examples referred to, the values or constants are as 187 and 292, their sections ($b\,d^3$) as 12 and 16, the weights applied as 120 and 420, and the lengths as 3^3 and 4^3.

If the deflections were in conformance with the formula, the values here deduced would be equal, instead of 187 and 292, the proportion of which is obtained by

$$\frac{187}{292} = {\cdot}64$$

of the deflection given by the formula. The deflection as furnished by the table for the second experiment is ·36; hence, as ·64 : 1 :: ·36 : ·56 = the calculated deflection of it,

When it is required to estimate the deflection for differing weights, lengths, and sections, and contrariwise, to estimate the weights, lengths, and sections for a given deflection.

Divide the deflections by the cubes of the lengths and by the weights. Or, multiply the deflections by the sections ($b\,d^3$). Thus, if the deflections are as ·15 and 1·20 inches, the weights as 125 and 250 lbs., the lengths as 1 and 2ft., and the sections as 1×2^3 and 2×2^3 inches.

$$\frac{\cdot15}{1\cdot20} \div \frac{1^3}{2^3} = \frac{\cdot15}{\cdot15} =$$

quotient of the deflections ÷ the cubes of the lengths, which, being equal, shows the deflections to be as the cubes of the lengths.

$$\frac{\cdot15}{\cdot15} \div \frac{125}{250} = \frac{\cdot0012}{\cdot0006} = \frac{2}{1} =$$

quotient of the reduced deflection ÷ the weights; hence, the deflections are but one-half of that due to the weights.

$$\frac{2}{1} \times \frac{1 \times 2^3}{2 \times 2^3} = \frac{16}{16} = \frac{1}{1} =$$

product of the preceding quotient and the sections ($b\,d^3$); hence, the reduced deflections to be as the sections.

Table of the Relative Elasticity of Various Materials (Trumbull).

Cast iron	1·	Oak	2·8
Wrought iron	·86	Pine, white	2·4
Ash	2·6	„ yellow	2·6
Beech	2·1	„ pitch	2·9
Elm	2·9		

General Deductions.

In cast iron the permanent deflection is from $\frac{1}{3}$ to $\frac{1}{4}$ of its breaking weight, and the deflection should never exceed $\frac{1}{3}$ of the ultimate deflection.

All rectangular bars of wrought iron, having the same bearing length, and loaded in their centre to the full extent of their elastic power, will be so deflected that their deflection being multiplied by their depth, the product will be a constant quantity, whatever may be their breadth or other dimensions, provided their lengths are the same.

The heaviest running weight that a bridge is subjected to is that of a locomotive and tender, which is equal to 1·5 tons per lineal foot.

Girders should not be deflected to exceed the 40th of an inch to a foot in length.

In cast iron the $\frac{1}{20}$th to $\frac{1}{30}$th of the breaking weight will give a visible set.

When a load on a girder is supported by the bottom flange of it alone, it produces a torsional strain.

A continuous weight, equal to that of a beam, &c., is suited to sustain, will not cause the deflection of it to increase, unless it is subjected to considerable changes of temperature.

The heaviest load on a railway girder should not exceed $\frac{1}{6}$th of that of the breaking weight of the girder when laid on at rest.

Deflection consequent upon Velocity of the Load.

Deflection is very much increased by instantaneous loading; by some authorities it is estimated to be doubled.

The momentum of a railway train in deflecting girders, &c., is greater than the effect from the dead weight of it, and the deflection increases with the velocity.

Experiments made by the Commissioners of Railway Structures of 1849 showed that a passing load produced a greater effect on a beam than a load at rest.

A carriage was moved at a velocity of 10 miles per hour; the deflection was ·8in. and when at a velocity of 30 miles, the deflection was 1·5in.

In this case 4150lbs. would have been the breaking weight of the bars, if applied in their middle; but 1778lbs. would have broken them, if passed over them at a velocity of 30 miles per hour.

Cast iron will bend to one-third of its ultimate deflection with less than one-third of its breaking weight if it is laid on gradually, and but one-sixth if laid on rapidly.

When motion is given to the load on a beam, &c., the point of greatest deflection does not remain in the centre of the beam, &c., as beams broken by a travelling load are always fractured at points beyond their centres, and often into several pieces.

Chilled bars of cast iron deflect more readily than unchilled.

Results of Experiments on the Subjection of Iron Bars to Continual Strains. (Rep. Comms. on Railway Structures.)

Cast iron bars subjected to a regular depression, equal to the deflection due to a load of one-third of their statical breaking weight, bore 10,000 successive depressions, and when broken by statical weight gave as great a resistance as like bars subjected to a like deflection by statical weight.

Of two bars subjected to a deflection equal to that carried by half of their statical breaking weight, one broke with 28,602 depressions, and the other bore 30,000, and did not appear weakened to resist statical pressure.

Of a number of bars subjected to a vibratory depression, equal to the deflection due to a load of one-third of their statical breaking weight, one broke at 51,538 depressions, and one bore 100,000 without any apparent diminution of resistance.

Of three bars subjected to a like character of depression, equal to the deflection due to a load of one-half of their statical breaking weight, they broke at 490,617, and 900 depressions respectively.

Hence, cast iron bars will not bear the continual applications of one-third of their breaking weight.

A bar of wrought iron, two inches square and nine feet in length between its supports, was subjected to 100,000 vibratory depressions, each equal to the deflection due to a load of five-ninths of that which permanently injured a similar bar, and their depressions only produced a permanent set of ·015 inch.

Three wrought iron bars were subjected to 10,000 vibratory depressions, depressing them through one-third, two-thirds, and five-sixths of an inch respectively, without receiving any perceptible permanent set.

A bar of wrought iron depressed through one inch received a set of ·06 inch, and one depressed 300 times through two inches received a set of 1·08 inch.

The greatest deflection which did not produce any permanent set was due to rather more than one-half the statical weight, which permanently injured it.

A wrought iron box girder, 6 × 6 inches, and 9 feet in length, was subjected to vibratory depressions, and a strain corresponding to 3752 lbs. repeated 43,370 times, did not produce any appreciable effect on the rivets.

SCOTTISH SHIPBUILDERS' ASSOCIATION.

ON THE CONDITIONS AFFECTING STEAM-SHIP ECONOMY.

By MR. ORME HAMMERTON.

(*Illustrated by Plate* 215.)

IN a previous paper "On Steam-ship Propulsion," communicated by me to this Association, I treated the subject at some length, particularly with regard to the form of steam vessels for efficient propulsion, though I abstained from considering the abstract conditions affecting the results, for want of space. I intend the present paper to form a sequel to the last, to enter more fully into some highly important details connected with the machinery, and to analyse a few interesting and remarkable peculiarities in that branch of the inquiry.

In dealing with the general question of propulsion I was under the necessity of assuming certain conditions, namely, the accuracy of Beaufoy's experiments, or rather the law which appeared from them to regulate the frictional resistance of water-borne bodies in motion, as a foundation for the formula given to eliminate the amount of power requisite to overcome the resistance of bodies in motion in fluids under given circumstances. And although some margin may generally be allowed in substituting practical values for purely theoretical deductions, still the following considerations will not require so great a latitude as those connected with fluid resistance.

In the present paper we will confine ourselves to the investigation of how far the condition of the machinery affects propulsion, and introduce, in the first place, the inquiry as to the advantage or otherwise of expansion as applied to marine machinery.

Most persons connected with machinery are acquainted more or less with indicator diagrams as usually obtained; and although there is more than one kind of diagram obtained from engines by the means of the indicator, still the most important, as regards results, is the one in daily use, the other two classes of diagrams being more useful as indices of the arrangement and accuracy of the relative positions of the valve and piston, and are therefore of no importance to the subsequent remarks.

In considering the wide question of the most beneficial method of employing steam, and the most economical amount of expansion, difficulties encounter us at every step of our investigation, on account of the subtle nature of the element with which we have to deal.

Expansion itself, being entirely dependent on the initial volume of steam or vapour compared to its terminal volume, has been found to be subject to a law known as Boyle's or Marriotte's, and is expressed by the formula

$$P\,x = P'\,x',$$

where P equals the pressure of admission, x equals the point of cut-off, P′ any other pressure corresponding to any other point, x'. Expressed in words it becomes—Pressures are inversely as their volumes.

Thus far there appears to be no difficulty, but a little further consideration will show that steam possesses temperature as well as volume and pressure. Dalton and Gay Lussac's experiments upon this subject tend to show that temperature decreases as volume increases; and since the pressure and temperature of steam are inseparably connected, we find the pressure absolutely due to Marriott's law becomes less applicable.

According to Gay Lussac and Dalton, if V and t represent volume and temperature of a given weight of steam, and V_1 the same weight of steam when its temperature is t_1, then

$$\frac{V}{V_1} = \frac{458 + t}{458 + t_1} \Big\} \quad . \; . \; . \; . \; . \qquad (1.)$$

where 458 is a constant.

Then, if P represent pressure of volume indicated by V and P_1 pressure at temperature t_1, if volume of steam remain the same, then

$$\frac{P}{P_1} = \frac{458 + t}{458 + t_1} \Big\} \quad . \; . \; . \; . \; . \; . \; . \; . \qquad (2.)$$

When volume and temperature are changed a combination of the two formulæ gives

$$\frac{V\,P}{V_1\,P_1} = \frac{458 + t}{458 + t_1} \Big\} \quad . \; . \; . \; . \; . \; . \; . \; . \qquad (3.)$$

In the case of steam, let $t_1 = 212°$ Fahr., $P_1 = 15$ lbs., $V_1 = 1700$, which represents the approximate value of the relative volumes of steam and water from which it is generated at the above-mentioned temperature and pressure.

Then, if P = 100lbs.,

$$V = \frac{1700 \times 15 \times (458 + t)}{P\,(458 + t_1)} = \frac{20094000}{67000}$$

= 294 as the relative volume. Conversely,

$$P = \frac{1700 \times 15 \times (458 + t_1)}{V\,(458 + t)} = 100 \text{ lbs.}$$

Introducing here a purely theoretical diagram (Fig. 1, Plate 215), and also others obtained from machinery in actual operation, it becomes evident that a material difference exists between theory and practice so far as Marriotte's law is concerned; and since the names of vessels and other particulars are of no importance in prosecuting the subject, I shall submit them merely as diagrams, and discuss some of their several characteristics. It will be seen that some of these figures present a singular feature, which one or two possess to a considerable extent, viz., the fall of pressure previous to the cut-off taking place; this defect, as is well known, is attributable to deficient area of portway or steam-pipe, or both, and is a very prevalent error. The intention in confining these apertures is probably to save steam, but the effect is very prejudicial, since the absolute pressure at the point of cut-off or suppression, and not necessarily at the time of admission, is the pressure from which the economy of expansion is obtained.

By reference to diagram Fig. 12, the amount of loss due to this source becomes apparent, where the actual diagram, shown in full black lines, and the theoretical figure, in dotted lines, indicate the difference. The amount of power so lost is 56 per cent.; and though the saving of steam may theoretically seem considerable, practically this result does not obtain, as experiments have proved. It is therefore unnecessary to enlarge on this subject further than to allude to a case in point, where experiments were made on the consumption of steam by means of throttling and expansion, the same initial pressure and speed of piston being maintained in both cases, resulting in a consumpt of steam of 35 per cent. greater by throttling; whence it can be easily conceived that deficient portway, which is equivalent to throttling in operation, is erroneous. The loss from this source is obviously considerable, and easily prevented; and though it may be argued that the consumpt must be somewhat diminished on account of the throttling action, still that argument is puerile, since, if such defective action produces good results, it cannot be assumed that better results are objectionable.

The moderate vacuum generally exhibited in these figures is not a defect properly speaking, at least in ordinary injection condensers, as the decreased labour of working the air-pumps is a greater advantage than any further attenuation of the vapour in the condenser would produce; and further, the ability of air-pumps, under ordinary circumstances, depends on the difference between comparative and absolute vacuum for the performance of their duty.

The gravest of all defects observable in many modern engines is attributable to a too extended range of expansion, which seems to occur to nearly the same extent whether steam of 10lbs. or 100lbs. pressure is adopted.

If in following the expansion curve of diagram Fig. 10, indicated by full black lines, we also follow, in the mind's eye, the motion of the piston, and for the sake of argument assume the atmospheric line to be zero—all pressures above that line will have a plus, and all below a minus value. The piston's motion commences under a plus pressure of 12lbs., which is properly maintained to the point (x) where the admission of steam is suppressed, after which the pressure gradually declines, until at the point (y) the pressure impelling the piston becomes, by our assumption, zero. The piston's motion, however, continues, and although this continuous motion is accompanied by a corresponding deflection in the expansion curve of the diagram, an important change takes place. Observe now that all the pressures have a minus value, so that, in fact, from the point (y) to the end of the stroke it is evident that, instead of a positive pressure impelling the piston forward, a negative pressure actually obtains, arresting its progress; and we must not here overlook the implied condition, that the vacuum below the piston has no connection whatever with the operation of the vacuum above it, since it is the abstract value of the steam expansion curve with the investigation of which we are immediately concerned.

The influence that such a result exerts upon the work done upon the piston is important, and deserves investigation. Analyzing this condition briefly, it is evident in any case that the negative pressures must be subtracted from the positive pressures to obtain the mean effective performance of steam, since all negative pressures are antagonistic to continuous motion when applied during the same stroke to the same side of the piston. It seems, therefore, evident that expansion should in all cases be arranged upon such principles as to prevent any partial destruction of its effect.

In diagram Fig. 10, if the steam were carried sufficiently over the figure, doubtless more power would be indicated and exerted, but more fuel would be consumed. It may be asserted that the extra indication thus obtained is of less importance than saving fuel, and that therefore the deficiency of the expansion curve is not objectionable. This position is, however, untenable, as after-consideration will abundantly show. Carrying steam well over the diagram is also advantageous in exposing a larger proportion of the surface of the cylinder to the action of steam whilst in communication with the boiler, and therefore a moderate amount of expansion (dependent, however, upon the pressure) can be effected without so extensive a demand upon the temperature of the steam during its expansion, at which critical time it ought rather to be receiving constant increments of heat than parting with it; and since the condensation from radiation varies from 5 per cent. when steam is admitted during the whole stroke, to 14 per cent. when cut off at the beginning, a further evidence of the loss due to excessive expansion, especially at low pressure, becomes apparent.

Steam has a maximum duty in practice which is attainable only by the proper regulation of the quantity admitted, no matter at what pressure; and, therefore, if any objection be raised to the increased consumption of fuel, the answer is conclusive,—reduce the area of piston, and this can be done with advantage whenever negative pressures are indicated in the diagrams.

Take, for example, diagram Fig. 10,* cylinders 70 inches diameter, with a speed of piston 266½ feet; pressure above atmosphere, 12 lb.; below 11 lbs. Suppression takes place after ·18 of the stroke has been performed, which, by Marriotte's atmospheric law, would give a mean pressure of 17.12 lbs. And it may be here advisable to remark, that by this law no negative pressures can occur, since any finite number divided by infinity equals zero, $\frac{a}{\infty} = 0$

It therefore follows that, in constructing a diagram which shall approach more nearly to practice, it is only necessary to alter the base by such an amount as will include negative pressures under the name of plus, or positive pressures. Thus, if we call absolute zero the base, we still have $\frac{a}{\infty} = 0$ correct, since it is impossible to obtain any pressure less than positive vacuum. Diagram Fig. 3 represents a figure of this form, represented by "Zero" law. This, however, does not agree with the practical line; but I have found that, by assuming the tension of the vapour in the cylinder as the base, we can not only approximate, but in most cases obtain a correct result in engines of medium construction. This coincidence is very extraordinary, as it is difficult to imagine a volume of steam admitted under a positive pressure so absolutely deprived of its effort as to exhibit a partial vacuum before the termination of the stroke. This is the case, however, and is sufficiently manifest in the figures. The indication of diagram Fig. 10 is 353·7 horse-power, and the mean pressure 11·38 lbs., being a deduction of 5·74 from the theoretical; but agrees exactly with the curve produced from the base or zero, which I have ventured to call the "Barometrical Zero," not for distinction only, but because it is derived from the state of the barometer or vacuum gauge, if attached to the cylinder, and which is duly registered by the indicator whenever it is applied. A figure of this form is represented by Fig. 2. Since the steam is only admitted for ·18 of the stroke in the case of diagram Fig. 10, it follows that ·82 of the stroke must be performed by the expansive action of the steam and the work accumulated in the piston. But by the diagram it appears that the steam has completely exhausted its power or force when ·375 of the stroke has been accomplished, leaving a residue of ·625 of the stroke to be completed unassisted, at least by steam, and, as before pointed out, is, after this point, subject to the retarding effect of a partial vacuum. If at this point a supply of steam were admitted of atmospheric density, so as to insure neutrality of pressure, the effect would be an increase of power developed. But power so obtained would not be an economical method of employing the steam, as in the case before us the initial volume of steam consumed is 16·04 cubic feet, at 12 lbs. pressure per stroke, at each end of the cylinder, which is equivalent to 28·31 cubic feet at atmospheric density by Pole's formula—

$$V = \frac{24250}{P} + 65,$$

* In figs. 10 and 11 the dotted line X P N is Marriotte's atmospheric law; the dotted line X Y Z (fig. 10) the proposed barometrical system. In fig. 14, the outline dotted figure X Y represents the barometrical system, and shows the deficiency of effect due to contracted ports, the full figure being taken by the indicator. The dotted line P S N is the barometrical line due to the pressure P O at the time of suppression. The defect below this is attributable to leakage of the valve on the exhaust side, and not to early exhaustion.

developing a power of 353·7 horse-power; whereas the prevention of partial vacuum occurring would entail the consumption of 55·67 cubic feet additional at atmospheric pressure, being 196½ per cent. more than the initial volume of admission. The power developed would become 476·2 horse-power, an increase of 34½ per cent.

Now, by introducing the same volume of steam initially, a very different result would be obtained: for instance, the total volume of steam of atmospheric pressure would become 83·99 cubic feet, which, reduced to its corresponding volume at 12 lbs., would be 47·58 cubic feet, and represent an admission of 5·341 of the stroke. The power developed by such use of this increased volume of steam to the extent of 196½ per cent. would be 746·7 horse-power, = 125 per cent. on the first power, and 321 per cent. on the power due to prevention of vacuum, giving a balance in favour of applying the steam initially of 57 per cent., without any corresponding outlay of fuel. If any argument can be considered conclusive, it is when it appeals directly to finance; and certainly the present case is an instance of this class.

That there exists a maximum condition of efficiency of expansion in all engines, and at all pressures, is beyond a doubt; and that I may conclusively show that this maximum is attainable, I shall divest the question of all connection with power and effect, which I consider without the province of expansion proper, and depending more upon details comparatively foreign to the subject.

Steam being an expansive element, the work derivable from it is divisible into two distinct quantities,—one due to its initial pressure and volume, the other to its expansive efficacy; and since its expansive force ceases the moment its pressure becomes equal to that of the atmosphere, it is clear that if this force ceases previous to the end of the stroke, or rather, I should say, previous to exhaustion, we do not obtain all the work contained in the steam which it is able to develop by its expansion. On the other hand, it is equally evident that if more steam be admitted than will by its full expansion decline before its exhaustion to atmospheric pressure, we do not obtain the full economical advantage of such steam. It therefore follows that neither of these cases satisfies the condition of maximum; nor can any other than that which admits of the terminal pressure at the time of exhaustion being of atmospheric density; and since every variation of pressure, however small, must be accompanied by the same result, it is clear that for every variation in pressure a variable amount of expansion must obtain. In the accompanying diagram, Fig. 7, I have endeavoured to represent the point of suppression due to any pressure when a maximum duty is desired. It is arranged on the principle of the ordinary displacement scale, so that the intersection of any pressure with the curve line will give the cut-off required. The method adopted in the prosecution of this inquiry is strictly elementary, and the results are concisely exhibited in the descriptive diagrams, Figs. 4, 5, 6. Perhaps the most certain check to inaccuracy consists in tabulating results, by means of curvilinear figures, as not only do those results indicate their generation, but they at once become appreciable to the mind, and also to the eye, enlisting this most valuable assistant in the discharge of the duties of conception, without which assistance the mind is rarely capable of sufficient concentration to follow the progressive development of any abstruse subject. In order to make the figures themselves intelligible, a description of their generating bases must be given. In the first place, I assume a base line which coincides with the barometrical base before alluded to, viz., the vacuum in the cylinder, and is therefore the practical zero. All the pressures are measured from this line, and are represented by ordinates, the base line divided decimally representing abscissa. My next object was to assume at the commencement of the stroke, at the left hand side of the figure, a volume of atmospheric steam equal to 1 cubic foot, which of course gives 11 cubic feet at the end; and since the volumes in the same cylinder vary directly as the lengths, the lines of volumes will be straight lines.

In order to make the volumes indicative of economy, I fixed upon a pressure of 12lbs. (diagram Fig. 4), at which to examine the results previously calculated, from ·05 of the stroke before suppression to full steam. At the pressure of 12lbs. and 11lbs. vacuum it became necessary to construct a new line of volumes (which was determined by Pole's formula), so as to maintain the consumpt of steam in cubic feet of atmospheric density. This line is indicated on the diagram by "volumes at 12lbs." The expansion was next represented by "expansion at 12lbs.," and was calculated, as in the case of total pressures, by Simpson's formula. Though this line merely represents the mean pressure during expansion, it deserves attention on account of being conspicuous in the result. The horse-power was next calculated for every ordinate, and indicated by horse-power at 12lbs. The same process of reasoning also led to the construction of the curves at 50lbs. (Diagram Fig. 5.)

The intrinsic value of these figures consists in the extraordinary proof they give of the accuracy of diagram Fig. 7, which was before observed to indicate the point of suppression for maximum economy in expanding steam. By referring to this diagram the point of suppression is given at ·46. In diagram Fig. 4 we find the line of volumes, the curve of expansion, the curve of horse-power, and the line of weights, all intersect at the point of ·46; and, above all, it becomes evident that the mean pressure throughout the whole stroke, compared with the volume admitted, is a maximum which is equivalent to obtaining the greatest effect from a minimum volume of water. The same result occurs also at 50lbs. (diagram Fig. 5), and would, consequently, at all pressures. It seems, therefore, conclusive, not only that a maximum exists, but also that it is exhibited in diagram Fig. 7; and, therefore, it is further evident that no machinery, however symmetrical or well-adjusted, is producing a maximum of power on a minimum weight when the amount of expansion is too great for the pressure. Thus far reference has been made to expansion only, independent of the power; but although power has many other elements than simple expansion to influence and determine its amount, and also although the resistances are the general indices of the point of suppression for maximum expansive economy, still these facts do not in the least interfere with the foregoing general deductions. Power is simply weight through space in time, and is therefore compound. In the case of steam engines, weight represents the mean load multiplied by the area of cylinder, and is itself therefore compound, and dependent both upon area and load. We can therefore vary these factors at will, providing that we rigorously maintain the equality. This method of consideration, however, is not sufficiently comprehensive, since economy demands the introduction of other items, viz., volume, weight, &c., and without their introduction the most absurd deductions are liable to be made, which fact will not require illustration.

Too few cases have come within my individual notice to determine whether the foregoing principle is really absolute in practice; but it is remarkable that, if we assume Lloyd's formula,

$$\frac{V^3 \; D^{\frac{2}{3}}}{H \;\; P}$$

as a standard of comparison, the best result with which I am acquainted was obtained by a cut-off agreeing with the proposed system (diagram Fig. 18.* Though not by any means perfect, it throws the co-efficient of the *Rattler*, 215·6, completely into the shade, being 318·5, and having a consumpt of coal astonishingly low, viz., 1·875lbs per indicated horse-power per hour. It is impossible to assert that on this account the proposed system of expansion is correct, but the coincidence is remarkable. Perhaps the data of some vessels accustomed to work with different amounts of expansion for several days together would furnish a more reliable source of comparison; but displacement would most likely be unnoticed, except the experiments were made by the authority of the commander or owners.

Evidently some position must be the most advantageous in cutting off steam; and, further, this point depends not only on the theoretical duty to be obtained from the use of expansion, but the weight of marine engines materially affects its determination, even although the benefit of expansion should practically agree with theory, which has hitherto not been found to obtain. Assume the theory of expansion to agree with practice, and ignore the question of weight, and it is evident that an amount of steam merely sufficient to obtain a vacuum is the most advantageous point of suppression, since more power would be developed per cubic foot of steam by this means, as the area of piston exposed to the action of vacuum is so great compared to the volume of steam consumed. But in practice this is perfectly inadmissible. By observing the line of weights which intersects the other developments at ·46, we have the value of the ratios of weights at any cut-off. This line represents the weights per nominal horse-power, and therefore does not vary with the point of suppression, and shows how great a variation per indicated horse-power can be made in the weight by altering the amount of admission. This line in the diagram shows that before point ·46 the weight in proportion to the power increases, and beyond this point, though the weight in proportion to the power decreases, we are trammelled by volumes, &c. The impression that expansion cannot be carried too far, on account of the heat contained in the steam not being completely extracted, may perhaps tend to prevent the proper conception of the importance of such a point as maximum economical admission of steam; but it must be obvious that whatever heat is left in the steam at the time of exhaustion will most assuredly be instantaneously extracted from it by its contact with the inferior temperature of the injection water, and will give out the power due to its temperature at the time of exhaustion, at least if not above that of atmospheric steam. For instance, if the temperature at the time of exhaustion were only equal to a vacuum of 3lbs. per sq. in. of piston, then 3lbs. would clearly be the total effect produced by the extraction of the remaining heat; and if the temperature at the time of exhaustion were equal to a vacuum of 13lbs., then 13lbs. would be the effect produced by the extraction of its remaining heat, and would be more efficacious and economical than power obtained from the attenuation due to excessive expansion.

A further elucidation of this condition may be obtained from a consideration of the weights, powers, volumes, and per-centage of waste from cooling in cylinders having different amounts of cut-off, consuming the same volume of steam. Diagram Fig. 6 is the result of this method of approaching the subject; the line of volumes is first described, being a constant, and equal in magnitude to the length of stroke, and is intersected at right angles by another which represents ·46 of that stroke. The point of intersection is the origin of the system. If the power of any cylinder be calculated with steam pressure agreeing with a cut-off ·46, viz., 12lbs., and let fall from the origin by any scale of equal parts, and this amount be also measured along a line drawn parallel to the line of volumes—calculating the power produced by the same volume of steam at all the other positions of cut-off in cylinders, the diameters and weights of which will vary with every power, and setting the results off both horizontally and vertically from the point represented by the distance of the power at ·46, from the line of intersection at ·46, a series of curves and straight lines will be produced. The weights in this case are calculated on the supposition that ·5 tons per nominal horse-power might be sufficient, and the formula

$$\frac{D^2 \sqrt[3]{s}}{47}$$

is the one adopted to eliminate the nominal horse-power. All are therefore represented with equal fairness. The speed of piston has, however, been assumed constant, which clearly would not obtain, as decreased diameter of piston would effect a saving in friction, cooling, &c.; and, therefore, although the smaller pistons appear to indicate somewhat less power, it would not occur to the extent exhibited in these diagrams. If we join the extremities of the curve of weights we have at ·46 a maximum.

So many things have to be noticed in determining the practical maximum for economy that it may be thought an impossibility. Increased pressure, however, and speed of piston, proper expansion, and lighter machinery, are incontestibly the particular elementary conditions of economy, and must sooner or later become of paramount importance to those whose interest is concerned in the production or maintenance of steam machinery.

The many peculiarities of these diagrams have, with me at least, considerable weight, since they seem to agree so well with both theory and practice, so far as proved, and would, I am sure, if further tested, be found correct. It is certain that the ordinary theory of expansive economy is a myth, as it has been frequently found that more coal has been consumed with early cutting-off than, in the same engines, with more steam admitted. This fact, coupled with the result of these investigations, have more than convinced me of the importance of some system being devised to guide, or at least to point out a probable course for securing the conditions of economy.

The saving of coals and the saving of steam by expansion are two widely different things. Steam may ostensibly be saved whilst coals are positively wasted, and though coal, when judiciously consumed, is a certain index to the power developed, still the medium through which that power is applied may be inadequate, and the result inferior to expectation.

Many experiments have been published, but without sufficient data, to prove the theory herein supported; but many facts have come under my own observation which indicate strong reasons for supposing it correct. The pure theory of expansive economy is insufficient to meet the innumerable practical difficulties which the steam has to encounter from its generation to its condensation, and the methods of treating these accidents theoretically are too abstruse for general application. We must therefore be content with combining practice with a sufficiency of theory to point out reasons for the many incongruities which arise in the daily routine of practice and observation. Thus far, however, this fact would seem to be undisputed, that the diameter of cylinder which, with the same volume, produces most power on a given weight, satisfies the condition of maximum economical efficiency, and that no other can do so.

A satisfactory result might also be obtained by assuming the resistances constant, and instead of a fixed speed of piston to suppose the speed to vary with the pressure, which would undoubtedly occur in practice. But a similar result obtains in the case already submitted, since the assumption is, that the resistances vary and the speed of piston remains constant. One peculiar indication of diagram Fig. 5, at 50 lbs., is an evident proof that high pressures are more economical than low, coupled with suitable expansion: this proof lies in the fact that more power is developed per cubic foot of steam admitted than is due to that volume, as exhibited by the line of volume falling below the intersection of the other developments, and the advantage is further enhanced by the weight of machinery not increasing in so high a ratio as the pressure.

To take a given cylinder, say 12 lbs. steam, 70 inches diameter, cut-off

* In fig. 18, X Y Z is the Barometrical System due to volume admitted, O P N the Barometrical System due to fall of pressure before suppression. This diagram agrees with the point of suppression referred to; the deficiency in the result or indicator line being due to insufficient portage.

at ·46, stroke 40 inches, the volume would be 75·4 cubic feet per stroke, giving 9·18 horse-power per cubic foot.

Whereas, in same cylinder, with 100 lbs. steam, cut-off at ·1066, stroke and same speed of piston, the volume consumed is 52·51 cubic feet, and 23·8 horse-power per cubic foot, being 2.59 times the power produced from the same volume of water.

The next important element in steam engine economy is speed of piston. It seems to me that greater speed of piston in marine engines would be very beneficial, and that almost any reasonable speed is attainable by reducing the relative effects of power and resistance.

It will not be too much to assume that power increases with speed of piston under all circumstances, and that speed is therefore a prominent element in the resolution of dynamical questions. Without speed power ceases to exist; but an infinite speed, coupled with an infinitesimal weight or pressure does produce power.

(*To be continued.*)

INSTITUTION OF MECHANICAL ENGINEERS.

ON THE CONSTRUCTION AND ERECTION OF IRON PIERS AND SUPERSTRUCTURES FOR RAILWAY BRIDGES IN ALLUVIAL DISTRICTS.

By Lieut.-Col. J. P. Kennedy, of London.

(*Illustrated by Plate* 216.)

The object of the present paper is to consider the most eligible construction for the piers and superstructures of railway bridges in alluvial districts, as regards economy in first cost, and facility and economy of erection in the colonies, in situations where the supply of skilled labour and mechanical appliances are very limited, and more especially in reference to the extension of railways as a means of facilitating the industrial development of the British colonies.

The mutual dependence of the several portions of the British Empire renders it a matter of great importance to all branches of trade and manufactures that the greatest possible facilities should be furnished for transport and intercourse in the colonies, and that communications should be opened in the most rapid and economical manner, for enabling colonial produce to reach the seats of manufactures. The importance of this is especially seen when it is considered what a great and rapidly increasing portion of the total exported manufactures of this country finds its market in the colonies, and particularly in India; and how rapidly this increase has progressed since improved means of communication have been adopted for conveying the manufactures into the interior of the country, and giving an outlet for the native produce and raw materials. Some remarkable facts are shown by a comparison of the consumption of British manufactures by the colonies and by the rest of the world; the total population of the British Empire being now more than 206 millions, or as much as one-fifth of the whole population of the globe, of whom six-sevenths are colonists. The consumption of British exports by the colonies is more than half as much as that by all other countries; and even in the present deficiency of the required facilities of communication, their consumption has trebled in the last twelve years, while that of the other countries has only doubled in the same time; although in India, from the great deficiency in means of communication, the average annual consumption by the whole population was only 1*s.* 2*d.* per head in 1855, increasing to 2*s.* 3*d.* per head, or nearly double in 1859; whilst in Australia it amounted to more than £8 per head, and to between £1 and £4 per head in the other British colonies. The great step in improving the means of internal communication has been the introduction of railways, which have commenced an entirely new era in the development of the resources of these countries; and since the first starting of railways in India in 1849 a remarkable advance has taken place. The annual consumption of British produce has increased from $4\frac{1}{2}$ millions sterling in the previous year, to 10 millions in 1855, and to $19\frac{3}{4}$ millions in 1859; the value to this country having thus been quadrupled within eleven years, and even doubled within the four years ending in 1859, including the period of the mutiny, with all its deranging effects on commerce.

In the employment of railways for this object, a consideration of great moment is the mode of construction of the piers and superstructures of the bridges, which form so large a portion of the works of a railway in many parts of India and other colonies, the construction of the piers especially having a particular bearing in alluvial districts upon the practicability and cost, and the consequent success of the line. A good illustration of this important subject is afforded by the works completed and in progress in the construction of the Bombay and Baroda Railway in India, with which the writer is connected, where a special construction has been adopted for the bridge piers and superstructures, in order to meet the difficulties of the alluvial district through which the railway passes, and attain facility and rapidity of erection combined with economy in total cost.

Most of the Indian railways take their course through rich alluvial plains and valleys where there is only one important natural impediment to their construction, consisting in the bridging of the rivers, many of which must be crossed within tidal influence; and all of them are swept by fierce monsoon currents, while their beds in general offer the worst class of foundations for the construction of masonry piers. They thus combine the greatest impediments to the erection of the usual description of masonry bridges. The great cost of erecting a bridge across the Thames at London is generally known; and yet in that case there are the best engineering talent and the greatest mechanical aid immediately within reach; and although the natural impediments are of the same class, they are far inferior in degree to those met with in Indian rivers.

The line of country traversed by the Baroda Railway in its level course of 310 miles from Bombay to Ahmedabad is more intersected by rivers of the above character than any other railway in India. So vast did the difficulties appear that the very practicability of constructing the line was seriously disputed; and not without reason, if it were assumed that the bridge piers must be executed upon the old stereotyped masonry plan, and that the engineer would not adopt those modern and well tested improvements that were applicable to the case. To those, however, who knew the precise nature of the local difficulties as well as the modern engineering improvements by which they could be surmounted, it was clear that this line could be effectually and economically executed, provided such modern improvements were applied; but by no other means could a maximum financial return for the outlay, which ought to be the first principle in engineering, be secured. The object was, therefore, to show that it was practicable to overcome with rapidity and economy the great characteristic difficulty opposing the construction of Indian railways, even where most prominently encountered. The writer accordingly proceeded to ascertain first all the engineering and financial requirements, and to investigate the comparative merits of all well tested improvements calculated to meet them; whence it was ultimately concluded that to bridge Indian rivers in alluvial districts on the old principle of masonry or brickwork would be both tedious and ruinous to the undertaking; but that the most difficult rivers so situated may be economically bridged by adopting wrought or cast iron for the piers, and wrought iron in the superstructures. The writer finally arrived at one pattern of bridge, admitting of extension or contraction to meet all the variations of circumstances that occur in such cases, as to the height or length of bridge and depth and nature of foundations.

The several applications of the plan to the different situations that are met with are shown in Plate 216. Fig. 1 is a general elevation, and fig. 2 a transverse section, of the Taptee Bridge, 1891 feet long, spanning a rapid tidal river; and fig. 3 gives the section of the bed of the river with the variations in depth enlarged eight times, showing the applicability of the same construction of piers throughout the entire length of the bridge.

Fig. 4 shows the construction of piers adopted in strong tidal rivers, such as the Taptee and Nerbudda rivers, where the depth of floods reaches from 40 to 60 feet, with a velocity of 6 to 10 miles per hour, and the force of the current, acting alternately in opposite directions on the piers, requires the addition of oblique piles to act as struts on both sides of the piers. The piers are composed of hollow cylindrical cast iron piles, of one inch thickness of metal and 2 feet 6 inches outside diameter, cast in 9 feet lengths, weighing about $1\frac{1}{2}$ tons each, as shown enlarged in Figs. 11 to 14; these are of two principal patterns, for the portions above and below the ground. Those above the ground, Figs. 13 and 14, have flanges outside for bolting them together by 12 one inch bolts; while those underground, Figs. 11 and 12, are flush on the outside, so as to offer no resistance in penetrating the ground; they are large enough inside to leave room for a man getting in to bolt the several lengths together properly in the process of erecting. The foundation is obtained by one of Mitchell's screws at the bottom of each pile, of 4 feet 6 inches diameter, which finds its own foundation, without the expense of cofferdams or any other artificial preparation of the ground. The upright piles are placed 14 feet apart from centre to centre, and are sunk to a depth of about 20 feet in the ground; but where the ground is softer than usual, they are carried down deeper, as shown by the dotted lines in Fig. 4, to obtain the requisite strength of foundation. The greatest length of pile used has been 45 feet below the ground and 72 feet above. The oblique piles forming the struts are inclined at an angle of about 30° to the upright piles; they are precisely the same in construction as the upright piles, and are joined to the latter at about the ordinary flood level by a cap cast at the proper angle, which clips the body of the upright pile. The piles are all connected together above ground by horizontal and diagonal wrought iron bracing, attached to lugs cast on the piles by a pin at one end and a gib and cotter at the other, as shown in Figs. 13 and 14; Figs. 15 to 18 show sections of the horizontal T iron bracings and the diagonal angle iron bracings. The several parts of the bracing act alternately as struts and ties according to the direction of the current, and in consequence of this alternate strain an accurate fit of the bracing is required; to ensure this the joints at one end of each are therefore left to be done in India from measurement on the site, this being the only forging required in India. The outside piles are faced with a double row of timber as a fender to protect them against shocks from anything floating in the water and brought down by the current. The weight of a single complete pier of five piles for two lines of rails, 63 feet high from the foundations, is 75½ tons, and the cost £624 delivered in London.

Fig. 5 is a side elevation of one of the spans of the bridge, showing the construction of the superstructure, which is that known as Warren's triangular system.* This form of girder, when manufactured and accurately fitted in England, requires the smallest amount of skilled labour for its erection abroad on reaching its destination, only a few pins and bolts have to be put in for completing the girders, and the skilled labour required for rivetting box girders or lattice girders is avoided. Fig. 19 is a plan of one roadway. As it is considered that uniformity of parts, as far as practicable, is of as great importance in bridge work as in other mechanical structures, a uniform span of 60ft. is adopted for all the iron bridges on the line, this being considered the most economical in reference to the general heights of the piers. One end of each girder is fixed on the pier, while the other end is left free to move, and carried on a pair of small rollers, to allow of expansion and contraction. The weight of the entire 60ft. superstructure for a single line of rails is 24 tons, being 8 cwts. per foot run, and the cost, at the present rate of iron, is about £400.

Fig. 7 shows the construction of piers adopted for inland rivers with deep water, say 20ft. to 50ft. deep, but not tidal, where the current is always in one direction only, as shown by the arrow. Here the oblique piles acting as struts are required only on the lower side of the bridge, and the timber fenders only on the upper side. Fig. 8 shows the piers for inland rivers with shallow water of not more than 20ft. depth, where the oblique piles can be dispensed with altogether. Where there is a rock foundation the screws are omitted, and the piles are simply let into the rock about 2ft. and filled round with cement, as shown in Fig. 9, allowing of great rapidity of erection in this case. The position of the roadway may be either between the main girders, or upon the top of them, as shown in Fig. 10. The upper position is preferable for the roadway, because it combines the effect of both the main girders in resisting forces that tend to produce buckling of the compression beams. The upper or lower position of the roadway, however, is decided by the amount of headway under the bridge, or the clearance between the bridge superstructure and the highest known flood level of the river, which should not be less than 5ft. In every case the power of the compression beams to resist buckling is made ample, and a horizontal diagonal bracing of T iron is provided between the cross girders carrying the roadway, as shown in the plan, Fig. 19, continued from pier to pier; and where the roadway is on the top of the main girders, oblique stays are added, as shown in Fig. 10, to secure the requisite stability and freedom from vibration in the roadway and girders.

A valuable proof of the strength of the piers erected in the manner above described, as shown in the drawings, was afforded by the exposure of the Nerbudda viaduct on the Baroda line to the monsoon of 1860 whilst still in an incomplete state, the works having been suddenly stopped by the cholera breaking out among the men. There were at the time only two piles erected at the last pier which reached into the middle of the stream, without any oblique piles to serve as struts in supporting it, as shown in Fig. 6; but the pier resisted the deepest and fiercest current of the river without sustaining any injury. At this bridge greater rapidity in screwing down the pier piles was latterly attained by applying animal power direct at the extremities of 40ft. levers made fast to the piles, without the intervention of crab winches or other multiplying wheels. Four of these levers, with 8 bullocks yoked to each, were applied to screw every pile. This plan would be applicable to all pier sites not permanently covered with water. Where any considerable depth of water exists, the practice hitherto has been to erect a temporary staging or platform upon timber piles, from which the permanent iron piles are screwed down by a lever and capstan worked by crab winches: but probably a more economical mode would be to use a floating stage carried upon well anchored pontoons. The principal element of strength in these bridge piers is the firm and accurate fixing of the horizontal and diagonal bracings between the piles from the bed of the river upwards. This and other necessary operations in deep water are effected by submarine fitters furnished with Heinke's diving helmets and dresses, which are indispensable in such cases.

Previous to adopting the Warren system for the bridge superstructures, the writer tested a girder of this construction of 60ft. span to the breaking point; and finding the results generally satisfactory, strengthened the parts very considerably in the subsequent designs, rejecting all cast iron and increasing the quantity of wrought iron beyond previous practice. An additional strength was thereby obtained which has already proved of great service, having enabled the Wiswamunta bridge to resist successfully the shock to which it was exposed by an accident arising from a malicious plot for destroying a special train on the 17th January, 1861; the train was thrown off the line by a rail placed across in front of the abutment, and broke some of the cross girders supporting the rails; but it was brought to a stand without material damage to the main girders and without serious injury to any one in the train. The regular test to which the superstructures have been submitted in England was 2 tons per foot run, or about double the maximum load that can be placed upon them in practice. This test load was rolled on in trucks from a siding: it caused a deflection of only ⅝ inch in the centre of each 60ft. span, and upon removing the load the girders recovered their original camber without taking any permanent set. The greatest strain to which any portion of the girders is subjected under the heaviest practical load is 3¾ tons per square inch of section.

The piers and superstructures for 95 bridges on this plan of construction have now been sent to India, comprising 477 spans, and making about 6 miles of viaducts upon the Baroda Railway; and the trains on the 132 miles opened within the last year pass over 33 bridges comprising 215 spans of 60ft. each. There has not been a single failure in the foundations with the iron pile piers, though nearly all the foundations were bad; whilst the attempt to erect masonry abutments even for 10 and 20ft. spans has failed in several instances in similar localities.

The rapidity of erection afforded by this mode of construction is well illustrated by the progress made on the second or central division of the Baroda Railway, extending over a length of 80 miles, and including the most difficult part of the entire line. Possession of the land for this portion of the line was obtained in October, 1858. The average amount of iron bridge viaduct on the northern half of this division, including the Taptee viaduct, was twice the average of the whole: about 40 miles in this locality, or 1-8th of the entire line, included one quarter of the total amount of bridge work. The Taptee bridge, 1891ft. long, spanning a tidal river and erected on an alluvial bed, shown in the diagram, Fig. 1, was opened for the passage of trains in November, 1860, within one year from the sinking of the first pile: this great work ranks second in point of difficulty on the entire line. These 40 miles of railway just completed occupied about 2½ years in construction, including 18 iron bridges making, up more than a mile and a half of viaduct, which were erected in only 15 months, a remarkable achievement in railway operations. These works being the first of the description executed upon a large scale, the writer was not able to meet with engineers experienced in their erection. Only one of the engineers on the line had previously erected a Warren girder, and only one had previously sunk a screw pile. None of the others had erected either piers or superstructures of this class; yet in this their first effort in the erection of railway bridges upon iron screw piles their success was as above stated; and with their increased experience they can now erect as many piers at a time as it might be found advisable to carry on simultaneously, each being completed in a fortnight; and they could cover the piers with their superstructures at the rate of one span in every two days. This rate of erection was nearly attained in practice in the construction of the division of the line above referred to.

An important essential to economy and rapidity of construction is to provide beforehand a large proportion of the permanent way and bridge materials, and to have both of them in readiness at the proper commencing point of the line before the earthworks are undertaken. This precaution would add to the economy of the results by enabling the materials to be carried forwards to their intended sites along the railway itself as soon as the rails were laid on formation level; and would admit of rapid ballasting as soon as the earthworks had received their first rains or moonsoon seasoning. It would besides have a beneficial effect in consolidating the banks by the transit of heavy loads prior to the ballasting and before opening the line for traffic. In order to secure the greatest regularity in the supply of materials in India, all the portions of each pier and span of superstructure should be shipped together in the same vessel.

The system of construction now described aims at maintaining the greatest practicable uniformity of parts and the smallest variety, with the greatest durability of pattern throughout all branches of the railway works. This can only be secured by well considered designs based upon strict tests. The first templates should be the best fitted to their object of any at the time in existence, and should be preserved until some indisputable improvement required a change. The greatest judicious uniformity of parts and designs is essential to the greatest attainable economy, rapidity, and cer-

* Illustrated and described at length in THE ARTIZAN of January 1, 1859.

tainty, both in construction and in after working. On this railway precise uniformity has been established between the corresponding parts of every pier and of every girder in its 95 iron bridges. Without such uniformity it would have been impossible to secure either the greatest precision of manufacture at home, the greatest rapidity of erection abroad, or freedom from the cost, inconvenience, and delay which must attend losses at sea, when each work is upon a special and separate design. In erecting the work each engineer, artificer, and labourer, becomes rapidly accustomed to his particular duty, and acquires increased expertness in its performance. The work at one point being completed, the men are moved to similar operations elsewhere with similar materials. The object has been to apply to the construction of great public works the principle of manufacturing success, namely repetition of the same operations by the same men throughout.

From the present state of iron structures of this class that have been standing for many years and have been well taken care of, their probable duration for 100 years may be inferred. This would bring them to between the ages of the old Westminster and Blackfriars masonry bridges: the former of these has for the last six years been in process of rebuilding, and the latter is awaiting a similar renovation. A comparison of the rate of cost of the Baroda Railway iron bridges with that of the old Westminster masonry bridge shows that the interest upon the capital saved by adopting the former, would, in about three years, amount to their entire cost, even in the absence of effectual precautions against oxidation. There is, however, no desideratum in practical engineering of greater importance than the discovery of such a protection against oxidation as shall materially extend the durability of iron structures.

The cost of the entire construction of the Baroda line may amount to about £11,000 per mile; but had the ordinary method of constructing the bridges been adopted, even if at all practicable, the cost must have reached from £16,000 to £18,000 per mile.

In connexion with the railways now in progress in India as main trunks, and considering that the country is at present absolutely without secondary roads converging to them, it becomes important to settle what is the most profitable description of secondary roads to adopt. That plan will be best which shall enable goods to be conveyed most cheaply, taking into account first cost, maintenance, and working expenses. Comparing an ordinary metalled road with a light tramway capable of being worked either by animal power or by a small locomotive engine, the cost of construction and the maintenance of the tramway may be assumed at double the amount per mile of the ordinary road; but the tractive effect of the same power on the tramway would be eight times that on the road, the effect of gradients being the same on each. Comparing steam with animal power for cost of traction, the former may be taken at half the cost of the latter with four times the speed. It may therefore be considered that the total cost of haulage by steam power on a tramway is one half that of animal power on a tramway, or one sixteenth that of animal power on ordinary roads, the speed being four times as great in both cases.

It is satisfactory that one native Indian prince, the Guicowar of Baroda, has set the example of constructing from state funds a tramroad converging to a trunk railway, having commenced a line of 20 miles length through a rich district foom Dubboee to the Meagaum Station on the Baroda line. This is to be opened as a horse tramroad before the next cotton season. Mr. Forde, the late chief engineer of the Baroda line, has undertaken the construction of this tramroad at a cost of £1300 per mile, using rails 12 lbs. per yard and a 2 feet 6 inches gauge. In the writer's opinion both the gauge of a tramroad and the weight of rail ought to be considererably increased beyond those dimensions; the gauge to be say 3 feet 6 inches, and the rail 28 lbs. per yard at least. The introduction of a minor class of railway or tramroad is a question of much importance, requiring the forethought and distinct arrangement of the government. It is quite as essential that a uniform gauge of road, height and gauge of buffers, and clearance gauge, &c., should be established for such minor roads as for the main trunk lines; otherwise there must be endless and costly unloading and reloading as the system becomes developed.

In conclusion it may be observed, with reference to the extension of railway communication in India more especially, that, with due facilities from the government in the construction and working arrangements, the railway companies will find themselves in a most favourable position to carry out their task, with every element that can secure the most satisfactory results. Taking the Baroda line as a sample, it traverses a vast, populous, and most productive district; its ruling gradient is 1 in 500; the cost of construction is expected to average about £11,000 per mile. or one-fifth of the rate of much easier lines executed in England; and it is protected by the establishment of a moderate rate of train speed. Such conditions must ensure safe travelling at low fares for the public, together with a liberal remuneration to the shareholders, and thus tend to restore the confidence of capitalists in similar beneficial operations, so essential to the progress both of England and the colonies.

ROYAL INSTITUTION OF GREAT BRITAIN.

ON SOME OF THE CAUSES, EFFECTS, AND MILITARY APPLICATION OF EXPLOSIONS.

By F. A. ABEL, Esq., F.R.S.

A glance was taken at the general nature and causes of the phenomena termed explosions, and attention was then specially directed to those explosions which are due to chemical agency.

In all instances of chemical action accompanied by an explosion, the production and violence of the latter are either entirely or principally due to the sudden and very considerable development of heat, which results from the disappearance, for the time, of chemical activity. The violence of such explosions is therefore regulated by the energy of the chemical action, or the degree of rapidity with which the chemical change takes place. There are instances in which the change of state (*e. g.* the conversion of solids into vapours and gases), resulting from chemical action, and the suddenness with which this transformation occurs would suffice to produce explosive effects, quite independently of the effects of heat developed by the change; but in all such instances the sudden increase in volume of the matter, resulting simply from the chemical change, is insignificant as compared with the expansive effect exerted, at the same time, by the heat developed in consequence of the sudden and violent disturbance of chemical equilibrium. Thus, the actual volume of gas produced on the decomposition of gunpowder, though very considerable in comparison with that of the original solid, is but small when compared with the volume which it occupies at the moment of its production, when under the influence of the intense heat resulting from the chemical change.

Explosions are occasionally produced by energetic chemical combination between elementary substances. Thus, potassium combines with bromine with explosive violence, in consequence of the powerfully expansive effect of the heat resulting from the intense and sudden chemical action between the two elements. Again, the union of hydrogen with oxygen or chlorine is so energetic, that the resulting water or hydrochloric acid is suddenly and enormously expanded by the heat developed; a powerfully explosive effect being consequently produced.

Explosions are much more frequently the result of chemical decomposition. Several classes of compounds are known, the unstable character of which endows them with explosive properties. Thus the compounds known as the chloride, iodide, and bromide of nitrogen are highly susceptible of instantaneous decomposition; the very slightest disturbing causes sufficing to destroy the chemical equilibrium which exists between their component particles. Compounds of silver and gold with nitrogen, hydrogen, and oxygen (fulminating silver and gold), and of silver and mercury with a peculiar organic group, generally known as fulminic acid (the fulminates of mercury and silver), are also highly susceptible of sudden, and therefore violently explosive, decomposition. By the action of nitric and nitrous acids upon several organic bodies, compounds of highly explosive characters are produced, their formation resulting from the abstraction (by oxidation) of a proportion of hydrogen-atoms from the original body, and the introduction, in their place, of a high oxide of nitrogen. The products of the action of nitric acid upon starch and cotton, in different forms, are the best known of these; among others, the substances known as nitromannite (obtained by the action of nitric acid upon mannite) and nitroglycerine, or glonoine (the product of the action of nitric acid at low temperature upon glycerine), are remarkable for the violence with which they explode when submitted to friction or concussion. One of the most recently-discovered and curious of these explosive organic bodies is the nitrate of diazobenzol, obtained by the action of nitrous acid at a low temperature upon aniline. This substance explodes at least as violently as iodide of nitrogen and fulminate of silver, if exposed to a heat approaching that of boiling water; it is, however, far less sensitive to friction than those two bodies. Similarly explosive substances have been quite recently obtained by Dr. Hofmann from derivatives of the interesting and important base, rosaniline, the salts of which furnish some of the most beautiful of the colours now obtained from aniline.

Explosions are most readily produced by establishing chemical action between certain substances, greatly opposed to each other in their properties, and brought together in an intimate state of mixture. The substances applicable to the production of such mixtures are, on the one hand, bodies remarkable for their great affinity for oxygen; and, on the other, compounds containing that element in abundance, and partly, or entirely, in a loose state of combination. To the first class belong the elements carbon, sulphur, and phosphorus, and compounds of the last two, with readily oxidisable metals; the second class includes a few of the higher metallic oxides (such as the higher oxides of manganese and lead) and combinations of metals with nitric, chloric, and perchloric acids. Mixtures produced with these two classes of bodies readily ignite, or afford explosions, either upon the direct application of heat, or by submitting them to friction, percussion, or concussion; and, in a few instances, by establishing chemical action in a small portion of the mixture, with the aid of some other compound. These explosive mixtures vary greatly in the ease with which chemical action is established in them, and in the rapidity and violence of their transformation; their properties are naturally regulated by the chemical and physical character of their constituents, and by the degree of intimacy of their mixture.

The variation in their explosive properties, and the great extent to which the characters of any particular mixture may be modified, are very important elements in their application to practical purposes; while the comparatively instantaneous nature of the decomposition of explosive compounds, and the facility with which it is brought about, present very great, and in many cases insuperable, obstacles to their employment as explosive agents. By the comparatively gradual decomposition of an explosive mixture, such as gunpowder (when employed as a charge in a gun), the force exerted, by the gases generated in the confined space, discovers, before it attains its maximum, that portion of the chamber enclosing the powder (*i.e.* the projectile) which is separated from the remainder. By the motion which it immediately imparts to this, the smaller mass, the strain upon the larger mass, forming all but one side of the chamber (*i.e.* the breech of the gun), is at once relieved, while the force continues, to the close of its development, to act in the direction of the mass which has once yielded to its influence, and thus propels the projectile. The explosion of a charge of a fulminate, on the other hand, in the chamber of a gun, is so instantaneous that the maximum of force is at once developed, and the strain thus exerted within the chamber, at the same time that it overcomes the inertia of the projectile (or the moveable side of the chamber), will also overwhelm the cohesive force which maintains the mass of the chamber entire, and the breech of the gun will therefore be shattered. Enclosed in a shell, a charge of a fulminate will produce a much greater shattering effect than gunpowder upon the metal enveloped, reducing it to a much larger number of fragments; but the pieces of the shell, produced by employing gunpowder as the bursting agent, will be propelled with much greater violence, because there is still a development of force after the rupture of the shell, while, with the fulminate, the entire force is at once expended upon the bursting of the shell.

The very great extent to which the rapidity of explosion of gunpowder may be modified to suit different applications, is one of the most important properties possessed by this material. A very rapidly burning powder is necessary in many instances; for example, in shrapnel shells, in which the charge of powder is required to break open the shell without interfering, by any great dispersive effect, with the flight of the enclosed bullets or fragments of metal. In mortars, and short guns also, a quickly burning powder is required, as they afford a comparatively limited space for the combustion of the charge. If a slowly burning powder be employed in such arms, a portion of the unexploded charge is expelled together with the projectile, the period between the first ignition of the powder, and the expulsion of the shot or shell from the gun, being insufficient for the combustion of the entire charge. In long guns and in rifled cannon it is very important, on the other hand, that the ignition of the charge of powder should take place gradually, so that the pressure exerted thereby upon the gun and the projectile should, after the first ignition, be as far as possible uniformly continuous during the passage of the shot or shell along the principal portion, if not the entire length, of the gun's bore. With the gunpowder which has been, until quite recently, in general use for large cannon, the actual explosion of a charge is almost entirely accomplished before the projectile has passed beyond the trunnions of the gun. Hence the rear portion of the weapon is subject to a strain which is enormous as compared to that sustained by the front part of the cannon. Numerous important advantages naturally result from a more uniform distribution of the pressure over the interior of the gun; for instance, the necessity of constructing the part reaching from the breech to the trunnions of very much greater strength than the remainder (a measure which, in the production of cast-iron cannon, involves considerable difficulties) is greatly diminished, and the risk of fracture of guns, or of their serious injury from submission to excessive strain, is considerably lessened. The explosive action of gunpowder may, it need hardly be observed, be easily regulated by the introduction of modifications in the proportions of the carbon, sulphur, and salpetre employed in its manufacture, and in the degree of intimacy with which the ingredients are mixed. Both of these expedients interfere, however, with the extent of force ultimately exerted by a given weight of the gunpowder; since, in either case, the chemical action between the ingredients would be modified. The rapidity of combustion of gunpowder, may, however, be admirably regulated, without introducing any alteration in its composition or in the perfection of its manufacture, simply by increasing or diminishing the size of the particles or grains constituting a charge; and also by modifying the degree of compression to which the gunpowder is subject before, or at the time of, its conversion into grains or pellets.

By combining the application of uniform and accurately regulated pressure with modifications in the composition of gunpowder, and by thoroughly confining the material within a case or receptacle, so that, if ignited, it can only burn in one direction, admirable and valuable arrangements (known as fuzes and time-fuzes) are obtained for igniting charges of gunpowder in shells at any period, during their flight, which may have been determined upon previous to the loading of the gun. By simple mechanical arrangements, regulating the amount of the compressed gunpowder which shall burn before the flame reaches the charge in the shell, the time of explosion is readily adjusted with the greatest nicety (subject, however, to variations depending upon the degree of density of the atmosphere, as recently shown by Dr. Frankland's researches). The principle of regulated compression, and of combustion in one direction, is applied to the preparation of rockets, signals, and numerous pyrotechnic arrangements, other explosive mixtures being, in some instances, substituted for the gunpowder.

The advantages offered by materials of a much more powerfully or rapidly explosive character than gunpowder, when employed simply as destructive agents (for instance, in many classes of mining operations), have led to repeated attempts at the application, as substitutes for gunpowder, of highly explosive mixtures, readily obtainable in large quantities, in which chlorate of potassa is employed, in the place of a nitrate, in conjunction with very oxidisable materials, such as the sulphides of arsenic and antimony, and compounds containing carbon and hydrogen (Callow's mining powder and white or German gunpowder are examples of such compounds). All attempts to manufacture and employ such mixtures have, however, invariably terminated in more or less disastrous results, in consequence of the comparatively low temperature at which chlorate of potassa exerts its oxidizing power. Very slight friction or percussion suffices to inflame many of these mixtures, and the violence of their explosive action is, in many instances, as difficult to control as that of explosive chemical compounds. Even in the manufacture and employment of comparatively so safe an agent as gunpowder, which may be subjected, without ignition, to tolerably powerful friction or percussion, and to the direct aplication of any temperature below that which suffices to ignite sulphur (about 550° Fah.), the neglect of strict precautions, for excluding the possibility of a particle of the power being subjected to sudden and powerful friction, may, and frequently does, lead to accidental explosions. The occasional accidents in gunpowder manufactories are generally enveloped in mystery, in consequence of their fearfully destructive effects; in all cases, however, where it has been possible to trace the causes of such explosions, they have been found in the wilful or accidental neglect of simple precautionary measures, indispensable to the positive safety of the works and operators.

The more highly explosive mixtures, and some few explosive compounds, though inapplicable as substitutes for gunpowder, on account of their great sensitiveness to the effects of heat, have, in consequence of this very quality, received important applications in numerous ingenious contrivances for effecting the ignition of gunpowder. Well-known instances of such applications are:—The employment of fulminate of mercury in percussion-caps; of a mixture of chlorate of potassa and sulphide of antimony, in arrangements for firing cannon by precussion and by friction, and for exploding shells by percussion or concussion; and of the same mixture, exploded at will, by being brought into contact with a drop of strong sulphuric acid, for the ignition of submarine mines or of signals.

Other mixtures, combining a high degree of explosiveness with power of conducting electricity, have been successfully applied to the simultaneous ignition of of numerous charges of gunpowder by electricity of high tension: by means of one of them, recently discovered, many mines may be simultaneously discharged, even by the employment of small magneto-electric machines; the necessity for employment of voltaic arrangements in mining operations being thus entirely dispensed with,

One of the most highly explosive mixtures at present known, consisting of chlorate of potassa and amorphous phosphorus, has been most ingeniously applied by Sir William Armstrong to the ignition of his time-fuzes, and to the production of concussion and percussion-fuzes, remarkable for the great ease with which they are exploded. The above mixture may be ignited by the application of a gentle heat, or by submission to moderate pressure; if it is made up into a hard mass by mixture with a little shellac-varnish, the friction resulting from the rapid insertion of a pin's point into the material suffices to ignite it, even when it is well covered with varnish. Thus, in Armstrong's time-fuze, which, when fixed in its place in the head of the shell, cannot, like ordinary fuze employed in smooth-bore guns, be ignited by the flame of the exploding charge of powder (as the shell accurately fits the bore of the gun), the fuze-composition is inflamed, immediately upon the firing of the gun, in the following manner:—A small quantity of the phosphorus-mixture is deposited at the bottom of a cylindrical cavity in the centre of the fuze, and over it is fixed a small plug of metal, with a pin's point projecting from its lower end. This plug is held in its place by a pin of soft metal, which by reason of the *vis inertiæ* of the plug, is broken when the gun is fired. and the pin then instantly pierces the pellet of detonating mixture, which, by its ignition, sets into action the time-fuze. The distance between the pin's point and the phosphorus-mixture, before the explosion, is only one-tenth of an inch. This arrangement exemplifies in a striking manner the delicacy of action which may be obtained by a judicious combination of simple mechanical arrangements and highly explosive materials.

The variety of work accomplished by the explosion of a charge of powder in an Armstrong gun loaded with a shell—no less than five distinct and important operations being thereby effected before the shell leaves the gun—affords a most interesting illustration of the progress made in the application of explosives, and of the comparatively great control which may be exercised over the operations of those destructive agents.

INSTITUTION OF CIVIL ENGINEERS.

ON THE SEA DYKES OF SLESVIG AND HOLSTEIN, AND RECLAMATION OF LAND FROM THE SEA.

By Mr. John Paton, M. Inst. C.E.

After referring to the vast extent of land enclosed by these dykes, as being probably greater than in any other part of the world, the author pointed out the changes to which the west coast of Denmark had been subjected, and the influence which such variations had had on the dyke works. In illustrating this part of the subject, the line of demarcation between the elevation and depression of the Scandinavian Peninsula was alluded to, and it was shown that south of this line there had been no general depression of the land for many centuries, an old Viking Harbour, on the Island of Romoe, being instanced as having undergone no change, although local variations had taken place. An account was then given of the principal storm floods which had occured on the Danish coasts during a period of two thousand years. The traditional state of the coast before the Christian era was then described, and its condition in A.D. 1240, and in 1860, was shewn by diagrams, from which it appeared, that the old boundary of the main land was outside the present islands, the collective area of which originally amounted to 1500 square miles. The author believed that these variations were owing to a general subsidence of the land (and not as understood by the term encroachment of the sea), and facts were adduced of the existence of vast submarine forests, and even submarine tumuli, in which stone and flint weapons had been found, assigned to an age nearly four thousand years ago. These forests, and also submarine peat bogs, in which were distinguished the fen plants of fresh water, together with trunks of trees, were met with almost everywhere on the coast, under the present surface of the sea, sometimes being covered with a depth of 12 feet of water. It was considered, for various reasons, that the sudden and general depression of the land propably occurred about two thousand years ago; while, at the same time, it was pointed out, that local subsidence and other variations had taken place. A great part of the marsh land rested on peat moss, and on water containing peat, which continued to sink until far below the level of the sea. The Wilster and the Kremper marshes in Holstein, covering an area of about twenty square miles, were illustrations of these changes. It was stated that when a boring was made, for the purpose of testing the nature of the ground, the rod suddenly dropped sixteen feet, and a stream of gas rushed upwards, and burned for several days. When a high rise of tide occurred in the North Sea, salt-water springs had burst forth from the marshes; and, had the pressure continued, the utter destruction of these marshes would no doubt have been the result. Immense exertions had been made to remedy the evils arising from these peculiarities. The phenomena noticed in these marshes, together with the salt water eruptions and curious storm floods, were considered as highly important in the design and construction of engineering works, and as affording the means of satisfactorily accounting for some of the most tremendous disasters on record, hitherto attributed to the bursting through of the protecting lands. It was believed that this view was confirmed by that remarkable case the formation of the Zuyder Zee, originally a fertile land of nearly two millions of acres, although a marsh resting on peat bogs. The author considered that the destruction of the isthmus between Steveren and Medemblik, was the effect and not the cause of that great eruption, and that the district was destroyed by the pressure and eruption of water from below, consequent on the sudden and great elevation of the water in the North Sea: and instances were adduced, showing a communication between the wells of that district and the North Sea. Other local peculiarities were pointed out; and the Island of Amrum was stated to have risen twenty feet since the time of the earliest recorded flood. Similar occurrences had taken place in other countries, but there were no positive traces of such upheaving on other parts of the west coast, or on the islands. Heligoland had lost seven parishes in less than two hundred years.

Although, in many places, the sea had washed away the shores, and cliffs, yet this was comparatively of limited extent, and a greater area of marsh land had been restored since the embankments were made; the inner marshes being always lower than the outer, while the forelands continually increased. The Lyster Deep, drainage of the country to the westward, and deep fiords on the eastern side of the Duchies were then noticed, as well as the formation of the Agger Channel, which occurred during the greatest storm flood on record, that of 1825. This storm flood arose from the south west, and some curious phenomena were observed during its continuance, the water rising to an extraordinary height and with singular rapidity, while it fell as suddenly. The author considered that this flood, as well as others, could not have arisen simply from the effects of violent gales in the North Sea, and he attributed them to volcanic movements of the bottom of the sea; alluding to the phenomena observable during the earthquake in Jutland, in 1841. In further corroboration, it was remarked that from the twelfth to the nineteenth century, two hundred and fifty-two earthquakes had occurred in the Scandinavian Peninsula and Iceland; the movements in the former being usually from S.W. to N.E., or almost invariably the direction in which the most disastrous storm floods affected the Danish coasts. It had been stated by Mr. Mallet, that during the great earthquake at Lisbon, the sea was much agitated along the coasts of Holland and Friesland, and vessels were dashed against each other; shocks of earthquakes and tremblings being felt at several places in Holstein, the water in the wells rising so high, as nearly to inundate the land in some places, while the River Eider was particularly agitated. The effect of these storms upon the Islands, and the protection afforded by the "dunes" were then commented on. The disappearance of the dunes between the Island of Amrum and the Eiderstedt was attributed to the washing away of the land on the eastern side; while at the same time it was pointed out that, at particular places, where the sandy dunes were levelled by occasional floods, they were singularly productive of grasses, a rental of £3 per acre having been realized, and under certain conditions, good crops of grain had also been obtained.

The construction of the dykes was then described in detail; historical records being given of the earliest forms, including the "Halligs," remnants of large tracts of land, which were shown to be of great antiquity. It was considered, that the preservation of the Halligs and of the islands was of vital importance to the whole of the marshes, the full force of the sea being broken on them before reaching the main land. It was noticed, as a curious fact, that while the forelands were forming rapidly, the Halligs were as rapidly decreasing; and that, consequently, the beneficial influence they exercised would probably cease with time. The Island of Pellworm was specially instanced, as possessing a vast influence on the maintainance of the marsh district; although, owing to its isolated and exposed situation the peculiar nature of the soil, and the gradual depression of the land, it was somewhat questionable, if the strong and perfect stone dykes, or indeed any other works, except the inclosure of the intervening space between the main land, would absolutely free the island from danger. The dykes were classified as summer dykes, inside, and outside or sea dykes. The former were the most ancient, having been constructed by the early settlers on the "Warfths," as a protection against occasional tempests. Details of the various forms of dykes were then given. Generally, in Slesvig, a slope of three to one was used on the seaward side, to a height of 10 to 12 feet above the ordinary level of the water. There was then a cess, or bench, of 10, 12, or 15 to 1, according to circumstances, the section being entirely dependent on the position, the extent of the foreland, its height above the ordinary flood level, and its exposure to the direct action of the waves and wind. The variations in the rise of the water on different parts of the coast had a considerable influence on the height of the dykes; and it was shown that a high level of the crown was not always desirable, the banks on the Island of Pellworm being instanced as illustrations. The application of the curved stone facing for defending the dykes appeared only to be justified under peculiar circumstances, and by the want of straw and the scarcity of labour in the time of danger; as it was thought to prevent the natural rising of the ground, and to cause a depression at the foot of the facing, besides being very expensive. The materials for and the mode of formation of the dykes, and the various plans of protection adopted, were then treated of. Above the ordinary flood level, grass plots, covered or uncovered with straw matting, were shown to be of much importance; while in exposed places, where every ordinary tide reached the dykes, the sea slopes were sometimes covered with straw matting, stitched down in a peculiar manner, or they were pitched with stone, or protected with fascine or hurdle works. These and other methods had all been adopted with uniform advantage, under the circumstances in which they had been employed, particularly that of protecting the slopes with twisted strawbands. It was stated that there was no feature in connection with the dykes of greater importance than the projecting works, or groynes, and diagrams were exhibited, illustrative of the extent to which they were now being carried out, some being constructed of great length, nearly 8000 feet, with the object of connecting one of the small islands with the main land. Numerous examples were given of their advantage in exposed localities, as at Schlenkulen, in Holstein, where there was a depth of water of from 90 to 100 feet. The author thought the skilful manner in which the Dyke Inspectors, both in Sleswig and in Holstein, had overcome the difficulties, entitled them to the highest commendation. He then alluded to the precautionary means adopted in time of danger, pointing out that by the laws regulating the Dyke lands, the inhabitants of the "Roogs" contributed to the maintenance of the Dykes, according to the position of their land, its exposure to danger, and the intrinsic value of the soil.

In conclusion, the author reviewed the general advantages of these works in England, Holland, and Denmark, and the results which had already been accomplished, as well as those which still remained to be achieved. He considered the true test of successful engineering enterprises to be, not so much the perfection of the gigantic works which had been raised up as monuments of skill, but rather the benefits they conferred upon the world. Judged by this standard, it was contended that no other engineering works were of more paramount importance than reclamations from the sea. It was observed that the country, which was originally a trackless waste, now consisted of some of the richest land in Europe, furnishing, together with the kingdom of Demark, corn to England to an extent only surpassed by two other great states of the world, besides vast numbers of cattle, sheep, and horses. These results were then compared with what had been accomplished in the Lincolnshire fens and in Holland, and it was remarked that the three marsh countries were capable of affording a larger supply of grain than was now imported from America, Russia, and Prussia combined. Indeed, independently of other great enclosure works, it was estimated that the annual revenue of those countries was at least 8 millions sterling, a sum equivalent to more than the net passenger receipts of all the railways in the United Kingdom. There were still upwards of 600,000 acres of land in England and Ireland, worth from £20 to £60 per acre, which might yet be reclaimed, and if similar districts in other countries were added to this calculation, the magnitude of the results could scarcely be overraetd. It was remarkable that, notwithstanding the many advantages attending reclamation works, which could now be effected at a less expenditure than formerly, by the judicious application of steam power, such enterprises were still regarded with suspicion and distrust, although they afforded the means of the soundest and most profitable application of capital.

NOTICES TO CORRESPONDENTS.

G. L. (Liverpool).—The slide valves are those known as Waddell's Patent, and are, we believe, similar to those fitted to the engines of the *Persia*.

J. W. (Alexandria).—The engines of the *Faid Gehaad* have not yet been indicated; we understand the vessel will very shortly leave Liverpool, when the result of the working of the engines shall be sent you. The fuel question has been replied to through your agent in London. There is no objection to that form of valve; they have been fitted, and work well.

E. S.—Shall be replied to by post.

D. C. L.—The pressure is 150 expanded down to 5 lbs.; the condensers, surface condensers, about 4 square feet to each horse power.

YOUNG ENGINEER, X, and others, shall be answered in our next.

G. H.—We should require a more detailed statement of the dimensions, and further sketches, to enable us to give the subject a notice in our pages. We shall be glad to receive the particulars in good time.

ERRATUM.

Our attention has oeen drawn by Mr. Joseph Gill to the following omission which occurs in his paper "On the Transformation of Heat in the Production of Mechanical Work," which appeared in THE ARTIZAN of April, at p. 80, second column, line 13 from top, after the words "when a large amount of heat" insert the following—[leaves the water on its assuming the solid form. The beneficient wisdom of such a disposition in the laws of material creation was strikingly pointed out by Dr. Black in his exposition of the doctrine of latent heat, though we have no satisfactory explanation of the probable molecular condition of the phenomena. Uncertain as we are about the real nature of heat;] "varied and extensive," &c.

REVIEWS AND NOTICES OF NEW BOOKS.

The Stevens' Battery.

In continuation of our notice of Mr. Stevens' "Memorial," which we inserted in THE ARTIZAN of last month, we think the following extract from the results of "Experiments upon the Armour Plating of the Stevens' Battery, Loading Heavy Guns by Steam &c.," will interest our readers, most especially at the present moment, when we are devoting so much attention to arrive at the best construction of vessel, mode of plating, &c., for our fleet of "Ironsides."

"A structure, representing in material and dimensions a section of the armed deck of the vessel, was fixed as a target upon a raft at a distance of 660ft. from the gun to be used. The raft was kept in its place by its own gravity and by guide piles. The target was about 4ft. wide by 8ft. long on its surface, and its base was about 15in. below the surface of the water, having a vertical height of about 2ft. 9in. exposed. The face of the target being fixed at an angle of 27½ degrees to the horizon, would present to a gun on a level with it a slope corresponding to that of the proposed deck or armour of the vessel; as the gun, however, was about 12ft. above the surface of the water, the angle of incidence or impact was about 28½ degrees." The gun was placed upon a temporary (stationary) carriage, constructed of heavy timber. Forward and aft of the trunnions were India rubber buffers to take up the recoil. Given weight of gun, 9883 lbs.

"FIRST EXPERIMENT, January 4th.—Load, 11 lbs. powder; a spherical solid shot, weighing 124lbs. Four shots fired. The first struck the target a little to the right of the centre, and about half-way up the slope of the surface exposed. Indentation, 1⅝in. (not perfect); no other yielding of the iron plates; no fracture whatever. Second and third shots missed the target. Fourth shot struck to the left of centre, and just above the surface of water. Indentation, 1¾in. No fracture of plates. These measurements include indentation and deflection, and are therefore liberal. A stricter measurement would, in my view, give less indentation. In both shots the ball was broken into countless fragment. Recoil.—The operations of the buffers seemed perfect. During these four discharges, the utmost recoil was 8in. from the original position of the gun. The reactive forward movement from this recoil reached an extreme length of 2in. forward of the original position. The gun came to rest from these vibrations too soon for any time to be noted. When at rest, its position was not appreciably different from its original position, the buffers having brought it to its place. The gun was loaded by steam, the gunners being covered and protected by a platform between them and the line of fire. This platform or temporary deck was made of ordinary rough plank, spiked down and through, within 3½ft. of the line of fire—was not started.

"SECOND EXPERIMENT, January 4th.—Three or four shots were fired from a Parrott rifle gun, 6$\frac{4}{10}$in. bor. Load 10 lbs powdor; elongated shot. One struck; did not have an opportunity of going to note effect myself, but learned that the indentation was 1in. During preparations for firing, witnessed rapid and novel operations of steamer *Naugatuck* out in the stream. By the action of two propellers she was turned rapidly on her centre, end for end, without motion in the direction of her keel, either ahead or astern. By letting water into her she was, in a few minutes, sunk to a proposed fighting line, covering her deck with water. The water was then pumped out, and she at once raised to her sailing draft. Did not note the exact time of these evolutions. They were, however, very rapid.

"EXPERIMENTS AT SAME PLACE; RAPIDITY AND EASE OF LOADING BY STEAM—SAME GUN.

"FIRST EXPERIMENT, January 11th.—Load, 11 lbs. powder; 124-pound spherical solid shot. Loaded and fired five times in 3 minutes 4 seconds, or 184 secodds consecutively. Average, 36·8 seconds;* shortest time, 25 seconds. Distance the charge was moved each time from place of deposit to centre of gun was 9½ft. Recoil, 8in. Distance of forward movement could not get.

"SECOND EXPERIMENT, January 11th.—Gun was then loaded with 4 lbs. powder, and solid shot weighing 220 lbs. Loaded with the same ease as before, it being carried up to the muzzle of the gun, and rammed home as readily as the loads of less weight. Recoil of gun 7⅝in. Forward reaction, 2in. Final position of gun after these experiments, ½in, aft of its original position.

"(Correct), A. W. CRAVEN."

Other books have also been received, but too late to enable us to give a notice of them in THE ARTIZAN of this month.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

HORSFALL AND OTHERS *v.* THOMAS.—This was an action on a bill of exchange, tried at Guildhall before the Lord Chief Baron, when a verdict was directed to be entered for the plaintiffs. The plaintiffs are the proprietors of the Mersey Ironworks, and undertook, under a written contract, to manufacture a steel gun for the defendant of certain dimensions. During the progress of manufacture some defects were discovered in the metal, which were got rid of, with the consent of the plaintiff, by increasing the diameter of the bore. The plaintiffs introduced a steel plug into the breech of the gun, of which the defendant subsequently complained, saying that it had been wilfully put there to hide a fatal defect in the manufacture. The gun was taken to Woolwich Arsenal butts and tested in the presence of the government authorities there, and found to possess merits of no ordinary character. It was fired many times, with various charges of powder and balls of different weights, and upon one occasion threw a ball a distance of nearly six miles. Ultimately the gun burst, and, as the defendant alleged, at the spot where the plug had been put in. The defendant gave two bills in payment for the gun, and paid one of them, but the second—the subject of the action—he declined to pay, pleading that he had been induced to accept it by the fraud of the plaintiffs. At the trial, upon the opening by the defendant's counsel, the learned judge stopped the case, expressing an opinion that the defence was no answer to the action. Mr. Bovill, Q.C., moved for and obtained a rule for a new trial, on the ground that, if the facts had been proved as opened by Mr. Honyman, there would have been evidence to go to the jury in support of the plea of fraud. Cause was then shown against the rule on the plea that there was no evidence of fraud in obtaining the bill, or in performance of the contract. In support of the rule it was urged that if the defendant had been made aware of the fact that the plaintiffs had put a plug into the gun he would not have accepted the bill; that the plug was put in to conceal a patent defect, of which the defendant had been kept in ignorance; and that there was ample evidence of fraud. Their lordships took time to consider their judgment.

DAVIS *v.* THE WEST MIDLAND RAILWAY COMPANY.—This case was tried at Gloucester when a verdict was entered for the plaintiff. The plaintiff sought to recover damages for the non-delivery within reasonable time by the defendants, of a portion of machinery belonging to a steam cultivator. On delivering the machine in question to the defendant's manager to be carried to Grantham, the plaintiff gave notice that if it was not returned to him he should lose £5 a-day. The company failed to deliver it at Grantham for fourteen days, and the plaintiff alleged that in consequence of the delay occasioned thereby he had lost the sum of £65, which he could have made by the profits arising from the use of the cultivator. At the trial it was agreed to be left to the Court of Exchequer to say on what principle the damages should be assessed, and what amount the plaintiff was entitled to recover. The court now held that he was entitled to something for the loss of profits, and assessed the damages at £35.

ROSS *v.* GREEN.—This action was brought against the defendant, a shipbuilder, to recover commission, which the plaintiff claimed in respect of certain contracts, which he alleged he had introduced to the defendant, but which had been concluded by the defendant without the plaintiff's intervention. It was stated that the defendant had entered into certain contracts with the Spanish Government for the construction of certain ships of war, and the plaintiff wished to ascertain what ships the defendant had built, and was building, and what money he had received, or expected to receive, and also what communications had passed between him and the Spanish Government upon the subject. The defendant declined to give the information sought, upon the ground that he was excused upon grounds of public policy, from disclosing his confidential communications with the Spanish Government. The Lord Chief Justice said it was not necessary to decide whether defendant was entitled to withhold confidential communications, but he should decide this case upon the ground that there was nothing to show that, in any sense of the terms, the communications in question were of a confidential nature. The defendant was not required to state the contents of the letters, but only the dates. Rule absolute.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention Chemistry as applied to the Industrial Arts (for which we are chiefly indebted to the *Chemical News*), Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Edit-or.

MISCELLANEOUS.

A NEW STEAM TRAVELLING CRANE.—Messrs. Ellis, of Salford, have just completed a steam travelling crane for the new battery works of the Government at Portsmouth. The crane is capable of lifting 20 tons with a pressure of 40lbs. It is worked by two small cylinders, with a perpendicular tubular boiler, and has three motions—longitudinal, horizontal, and perpendicular, with a span of 54ft. The engineer, who stands in front of the crane, has all its motion perfectly under his command, and can double its power with the utmost facility. A water tank and pump for supplying the boiler are also connected. The steam crane will do double the work of an ordinary 10-ton crane worked by six or eight men, and in half the time.

AN INVENTORS' INSTITUTE.—A preliminary meeting of inventors and others interested in patent property, has been held at 26, Great George-street, Westminster; and an association, to be called the "Inventors' Institute," formed for the following objects, viz.:—To unite and organize the influence of inventors and patentees; to facilitate the progress of science in connection with inventions; to obtain a simple and efficient administration of the patent law; and, generally, to protect the rights and promote the interests of inventors. The annual subscription is to be one guinea; life terms, ten guineas. A provisional committee has been appointed, of which Mr. Robt. Richardson, C.E., of 26, Great George-street, Westminster, was elected the chairman.

MINERAL OILS AND THEIR USES.—A sample of the Canadian oil has been forwarded to Dr. Muspratt for analysis, and he finds each 100 parts to yield upon distillation—of light coloured naphtha, having a specific gravity of 794, 20 parts; heavy yellow naphtha, with a specific gravity of 837, 50 parts; lubricating oil, rich in paraffine, 22 parts; tar, 5 parts; charcoal, 1 part; and loss, 2 parts=100. From this it will be seen that one-half of the crude oil consists of an illuminating fluid of great purity and absolutely safe, and by extracting the lighter spirits from the 794 naphtha, as is stated to be so successfully done by the Asphaltum Company, and leaving more of the paraffine in these naphthas, it would not be difficult to bring into the market, from every 100 gallons of the crude oil, 80 gallons of good quality illuminating oil, and in addition to which there would be the profits derivable from the lubricating oil and the mineral turpentine, so that the treatment of the oil cannot fail to be remunerative to those engaged in the business. At present sulphuric acids and alkalies are, no doubt, dear in Canada and Enniskillen the place at which the wells alluded to are situated has not very great accommodation for getting the oil to market, but these are obstacles which in the course of a few months will have entirely disappeared. So far, all that has been thought of is the rendering of the crude oil marketable principally as an illuminating oil, because in this form it would be most readily saleable in the Canadian market, but some disadvantages would result from treatment in this way, and consequently if a market be secured in Europe the profits would be much larger. The product which Dr. Muspratt inaccurately describes as light-coloured naphtha is really a similar product to that sold as benzole, which is the basis of the very beautiful colours described by Dr. Crace-Calvert, F.R.S., in a paper recently read before him before the Society of Arts. The so-called heavy yellow naphtha is an inexplosive illuminating oil, which would sell readily at the price of the best paraffine oil; it is, in fact, a superior kind of Belmontine oil, and if its more valuable portions were removed by bleaching it would be difficult to distinguish it from Belmontine. As the raw material for the manufacture of gas, the Canadian oil is especially valuable; in fact, the crude oil can scarcely be distinguished from the hydrocarbon, used by Mr. John Leslie, of Conduit-street, London, for the instantaneous manufacture of gas of high illuminating power, and proposed by him to be exported to all parts of the world. It could even be used as a substitute for coal itself in stoves which are constructed for burning it; usually, however, preference would be given to the manufacture of gas, and then to use the gas as the heating medium. The petroleum oil is also useful as a wood-preserver, and when forced through the pores, as in Boucherie's process, will last for a very lengthened period without showing signs of decay.

LONDON FIRES.—The report of the select committee appointed by the House of Commons, on the motion by Mr. Hankey, has been printed. After calling attention to the fact that the number of fires in London has increased from 458 in 1833 to 1183 in 1861, and noticing that "London" now, taking only the area of the Metropolitan Board of Works, covers about 170 square miles, and has 360,000 houses, the committee express their opinion that the parochial arrangements required by law for the extinction of fires should be discontinued; though maintained at a cost supposed to be nearer £10,000 a year than £5000, they are useless, or worse. The Fire Brigade establishment of the insurance-offices is also totally inadequate to the general protection of London from fire, nor can the offices be expected to undertake the task; their object is the especial protection of those parts where the largest amount of insured property is to be found; they are, moreover, anxious to give up the brigade. But its efficiency is such that the committee consider that the services of the existing staff ought to be made available in connexion with any new system which may be adopted. The valuable services of the Society for the Protection of Life from Fire, also demand public acknowledgment. In Liverpool the fire brigade forms an integral part of the police force; the arrangements are very efficient, and yet the annual expense is but about £2800. At Manchester and Glasgow also the arrangements are made under local Police Acts; the expense is about £2000, and half of it is recovered from the owners of the property in which fires occur, or from the insurance-offices. It was proposed in the committee that such a charge should be made upon owners or insurance-offices in London, but the numbers were equal on a division, and the chairman gave his vote with the Noes. In these three towns there is an almost unlimited supply of water at a high pressure, so that hose pipes are applied to the water mains, and the use of fire-engines almost dispensed with, but such a supply for the whole of the metropolitan district, requiring as it would a new system of fire mains, could not be effected without a cost of about £3,000,000; better regulations, however, might be made for the immediate attendance of the fire-cock men. The committee came to the determination to recommend that a fire brigade be formed in the metropolis as part of the police establishment. They add that it will probably still be found advisable for the owners of large property, such as the docks, to maintain fire brigades of their own, and that it may be reasonable for owners of large property where goods are peculiarly exposed to the risk of fire, to maintain some special protection for their own property beyond that which is provided at the general expense.

PARTITIONING OF THE BRITISH MUSEUM DEPOSITS.—The Chancellor of the Exchequer in the Commons, has brought in a Bill to enable the trustees of the British Museum to remove portions of their collections. The object of the bill is to enable the trustees to remove certain portions of their collection to South Kensington. The bill also contains provisions with regard to certain outlying parts of collections, not strictly contained in these collections themselves.

MACHINERY FOR PRINTING CALICOES.—An idea may be formed of the extraordinary influence which the introduction of machinery and improvements in engraving have had in cheapening the cost of printed calicoes, from the statement made by Professor Calvert, of the United States; that large furniture patterns, such as are required for some of the oriental markets, and into which sixteen colours and shades enter, would have cost formerly from 7 dol. to 9 dol. per piece, because they would have required sixteen distinct applications of as many different blocks, and would have required more than a week in printing, whereas the same piece can now be printed in a single operation, which takes three minutes, and costs about $1\frac{1}{2}$ dols.

THIS YEAR'S EXPORT TRADE OF IRON.—In the first quarter of the current year the shipments of pig iron increased from 62,400 tons last year to 87,667; bar, bolt, and rod iron from 53,063 to 59,579 tons; cast iron from 10,556 to 11,638 tons; hoop, sheet, and boiler plate iron from 15,385 to 16,800 tons; wrought-iron of all sorts from 19,097 to 21,786 tons; and unwrought steel from 5,251 to 5,284 tons; but railway iron of all sorts sorts has fallen off from 605,782 to 482,530 tons, and iron wire (except telegraphic wire) from 3625 to 1629 tons. France has been our best customer this year for pig and bar iron; Spain for railroad iron; Australia for cast and wrought iron; and the United States for hoop, sheet, and boiler-plate iron, and unwrought steel. The exports of lead increased from 3967 to 4716 as compared with last year, but seed oils have fallen off from 2,114,676 to 1,538,945 gallons; painter's colours from £101,120 to £92,307. Of machinery (other than steam engines) the value exported this year has been £431,826 against £540,978 in 1861, and £489,988 in 1860, but in steam engines the increase has been considerable. Telegraphic wire and apparatus show an extraordinary increase, viz., from £24,362 in 1860, and £3408 in 1861, to £95,884 this year. The total value of our exports during the first quarter of the year was in round numbers, in 1860, thirty millions, in 1861 twenty-seven millions, and in 1862 twenty-six millions.

MERRYWEATHER AND SON'S STEAM FIRE ENGINES.—The carriage of this engine which is of a novel form, combines as much lightness as is compatible with the required strength; the wheels are large, to facilitate rapid transit; the springs are of the very best description, and the framework of the carriage is pivoted on the fore carriage, to avoid all possibility of straining from unevenness of the road. Between the hinder wheels is placed the boiler, made of steel, with copper tubes arranged upon the circulating principle, and so perfectly has this principle been carried out that steam of 40lb. pressure has been generated from cold water in nine minutes. The steam cylinder, which is direct-acting, is 9in. in diameter, with 15in. stroke, working a patent double-acting pump, $6\frac{1}{2}$in. in diameter. The piston carries an oil chamber, which lubricates the pump barrel at every stroke, and, passing beyond the ends of the cylinder, completely empty it, so that any grit or other foreign substances that may be drawn up with the water are at once ejected; the suction and delivery valves are all placed in easily accessible valve chambers beneath the pump barrel. The mode of working the slide valve is novel and ingenious, permitting any required speed, from 1 to 150 double strokes per minute to be obtained at pleasure without the use of any fly-wheel. The prevalence of wind has of late been very unfavourable for trials of fire engines; however, with single jet of $1\frac{1}{8}$in., $1\frac{1}{4}$in., and $1\frac{1}{2}$in., most satisfactory results have been obtained. The latter jet, held at an angle of about 35°, was projected over an intervening building, to a horizontal distance of 216ft.; the engine lifting by suction 14ft. perpendicular, and half a gale of wind blowing dead against the jet.

NAVAL ENGINEERING.

SCREWS FOULING.—The plan suggested by Mr. Cunningham, the inventor of the patent topsails, for protecting the screws of our ships of war from fouling by the wreck of spars and rigging shot away and falling alongside in action, or from hawsers towing overboard in the vicinity of the screw, was tested on the 6th ult., in Weovil Lake, in the presence of several naval officers. The results were most satisfactory.

HYDRAULIC ARMOUR-PLATE BENDING MACHINES.—Messrs. Westwood, Baillie, and Co., Poplar, have lately manufactured five hydraulic armour plate bending machines, having their patent reversing gear, for Her Majesty's dockyard. These massive and powerful machines (each weighing about 40 tons), are capable of bending and twisting armour plates of 5ft. wide, up to 7in. or 8in. thick, and of any length, to any shape required for iron-cased frigates; these operations being performed upon the armour plates while cold, affect a great saving of time, fuel, &c. The fibre of the plate, also, is subject to no deterioration from the action of the heat, which under the usual method, it would necessarily have to undergo. These machines are also extremely useful for effectually bending or straightening keel-bars, large shafts, or any similar large pieces of iron while cold.

COWPER COLE'S CUPOLA PRINCIPLE.—Arrangements are nearly completed at Her Majesty's dockyard at Sheerness, for the construction of a new iron-cased steamer, to be built on Cole's cupola principle, with two shields. The dimensions of the vessel are as follows:—length between perpendiculars, 185ft.; length of keel for tonnage, 148ft.; extreme breadth, 42ft.; breadth moulded, 41ft. 9in.; depth in hold, 19ft. 10in.; and burden in tons, 1385. She will draw about 16ft. of water forward, and 17ft. aft. Her stem will be contructed somewhat after the pattern of the *Defence* and the *Resistance* iron-cased frigates. What has been chiefly kept in view in the design of the vessel, is to combine great speed with great power of resistance.

"THE NORTH STAR," which is in frame in the building slip at Sheerness, is to be proceeded with, and adapted to receive iron plates of sufficient thickness both above and below the load line, to enable her to ward off a 32lb. shot. Her sides are to be lined with plates sufficiently strong to resist a shell. Plans have been submitted, by which this vessel and others of a similar class now in course of construction, will be plated, and adapted for long voyages.

ONE of the mortar-vessels selected from the squadron of mortar boats at Chatham, which were built during the Russian war, is to be immediately prepared for the reception of the trial of a 150-pounder rifled gun now in course of manufacture by Sir W. Armstrong, in order that some experiments may be made with it upon the iron floating battery, *Trusty*, 14 guns.

THE "RESISTANCE."—The sum which the Admiralty have decided on paying Messrs. Westwood, Baillie, and Campbell for building the iron screw steam frigate *Resistance*, 18, 800 horse-power, including the additional fittings and work on board, and not specified in the contract, is £167,850, or rather more than £45 per ton.

CERTIFICATED ENGINEERS FOR STEAMSHIPS.—The Merchant Shipping Acts and Amendment Bill, as amended in Committee, has lately been published. The fourth section enacts that every steamship required to have a master, possessing a certificate from the Board of Trade, shall also have an engineer or engineers possessing a certificate from the Board of Trade. There are to be first-class and second-class engineers' certificates. Every foreign going steamship of 180-horse power, or upwards, is to have two certificated engineers, one having a first-class, the other a second-class certificate. Foreign-going steamships of less than 100-horse power are to have an engineer having a second-class certificate, a regulation which applies also to every sea-going home-trade passenger ship. Every person having engaged to serve as engineer, without being at the time possessed of such certificate as is required, and every person who employs anyone in such capacity, without ascertaining that he is entitled to and possessed of a certificate, will incur for each offence a penalty not exceeding £50. The Board of Trade will, under this Act cause examinations to be held from time to time of persons desirous of obtaining certificates of competency as engineers; the Board to lay down rules as to the qualifications of applicants, as they may deem fit. To every applicant who is reported to have passed the examination satisfactorily, and given evidence of his sobriety, experience, ability, and general good conduct on board ship, the Board of Trade will deliver a certificate of competency as chief engineer or assistant engineer, as the case may be. Certificates of service as engineers, differing in form from the above, will likewise be granted, and every person who, before the 1st of April, 1862. has served as first engineer in any foreign-going steamship of 100-horse power, or who has attained the rank of engineer in the service of Her Majesty, or of the East India Company, shall be entitled to a first-class certificate; also, every person who, before the date mentioned has served as second engineer in a foreign-going steamer of 100-horse power, or as first or only engineer in any other steamship, shall be entitled to a second-class certificate. The fees to be charged upon examination of engineers, under the authority of the Board of Trade are, for a first-class certificate, £2; for a second-class certificate, £1.

THE "ENTERPRISE."—This experimental powerful sloop of war is to be armed with the heaviest Armstrong guns at present in use, viz., 110-pounders. Her dimensions are to be: 180ft. in length; 36ft. in breadth; and 15ft. in draught of water. The timber frames, planking, shelf-piece, and water-way of the vessel will be made to serve as "backing" for the armour, which will be equal in resisting power to that of our largest ships. The offensive power of this new vessel, which will be of about 1000 tons burden only, is even greater, in proportion to her tonnage, than that of the *Defence* and *Resistance*. The entire superintendence of the *Enterprise* has been entrusted to the designer, Mr. E. J. Reed.

THE IRON-PLATED NAVY OF FRANCE.—The *Revue Contemporaine* states that the plan of the first iron-plated frigates was signed March 20th, 1858, long before the matter was approached by England or any other country. There are now four of these frigates afloat, the *Gloire*, the *Invincible*, the *Normandie*, and the *Couronne*, all of which have been tested at sea, with the most satisfactory result. Each of these has an armament of thirty-six rifled guns, of which thirty-four are in the battery, which is plated with iron from end to end. Two guns only are placed on the upper deck, and will carry four miles. The crew is composed of 570 men, the engines are 900 horse-power, and the length of the ships is 231ft. Besides these there are four iron-plated batteries, intended not for sea but for harbour defences; they are the *Pehio*, the *Saigon*, the *Paixhans*, and the *Palestro*; these are not yet quite complete. Two more iron-plated frigates, on a plan different to the *Gloire* are building, the *Magenta* and *Solferino*. Besides these there are ten other frigates of 1000 horse-power building in the Imperial dockyards, and six new floating batteries have been ordered by private builders, and are being pressed on with all haste. The iron fleet of France thus consists of 16 frigates, afloat or nearly completed, and 10 floating batteries.

THE FIRST of the large plate bending machines for preparing and bending the armour plates for the iron steamer *Achilles*, 50, by means of hydraulic pressure, has been erected at Chatham dockyard, in the factory adjoining the dock in which the iron frigate is building. The plates are to be bent cold.

THE *Couronne* iron-plated frigate, now at Cherbourg, is to be submitted to a decisive trial. She is to cross the Atlantic. The possibility of an iron-plated frigate performing such a voyage has long been the subject of discussion among seamen; a solution of the problem had, consequently, become necessary. The shipwrights in Lorient, where the *Couronne* was built, are confident that she will perform the task without difficulty.

STEAM SHIPPING.

THE HIBERNIAN STEAMER *Galway Line*, which was built by Messrs. Palmer, of Yarrow, and has been rebuilt by Messrs. Laird, of Birkenhead, recently made a trial trip. During the trial, she drew 16ft. 4in. forward, and 18ft. 7in. aft.; and she ran the measured distance at the rate of 14½ knots. She answered her helm quickly, turning at full speed in 6¾min. A hurricane deck has been built, sheltering the vessel from the paddle-boxes forward; the stearing wheel is placed on the bridge.

THE "SAMPHIRE," London, Chatham, and Dover Railway Company's steamer, made the voyage, on the 13th inst., from Calais to Dover and back, with as great, if not greater speed than has ever before been attained by any vessel. She was 1hr. 23min. from Dover to Calais, and 1 hour 18min. from Calais to Dover, the former being at the rate of 15·762 nautical, or 18·252 statute miles per hour, and the latter 16·769 nautical miles, or 19·418 statute miles per hour. The mean speed was 16·265 nautical, or 18·825 statute miles per hour.

THE "LUCHANA," screw, of 520 tons, built and engined by Messrs. W. Simons and Co., of Renfrew, has made a satisfactory trial trip, her speed having been one mile per hour greater than the rate originally prescribed in the contract.

MESSRS. MCNAB AND CO., of Greenock, are now engaged in engineering the *Arabian*, a screw of 3600 tons; owned in Liverpool, and intended to trade between that port and the Mediterranean.

THE "QUEEN OF THE ORWELL," intended to trade between Ipswich and London, has been launched by Messrs. Napier, of Glasgow, and her engines, fittings, &c., being completed, will be placed upon her future station. Her dimensions are:—length, 170ft. 6in.; breadth, 18ft. 5in.; burden, 290 tons.

EXPERIMENTAL SCREW TRIAL.—The *Shannon*, screw frigate, Capt. Wainwright, made her preliminary trial of speed with the Admiralty screw, leading corners cut, at the measured mile in Stoke's Bay, on the 16th ult. The ship's draught was—forward, 20ft. 3in.; aft, 21ft. 9in. Six runs were made at the mile with the following results in knots:—1st run, 11·538; 2nd run, 10·315; 3rd run, 12·500; 4th run, 9·944; 5th run, 12·857; 6th run, 9·783; the mean result of the whole was 11·288 knots. The pressure was 20lb., and the vacuum was, forward, 25, and aft the same. With five men at the wheel, hard-a-port, the circle was completed in 7 minutes 43 seconds; hard-a-starboard in 7 minutes 24 seconds. In the first instanee the rudder was only got over 12½ degrees, and in the second 14 degrees. Apart, however, from this difficulty in getting the rudder over when under steam, a difficulty common to all our screw ships, the *Shannon* steers admirably. She instantly answers the slightest touch of her wheel. On the 17th ult. the *Shannon* steamed out of Portsmouth harbour again for the trial ground in Stokes Bay. The screw tested on this occasion was the double-bladed "Mangin." It was cast in the new foundry of Portsmouth dockyard, but copied from the screw now in use in the French Imperial navy, into which it was introduced by M. Mangin, the inventor, some few years since. This screw was fitted to the *Austerlitz* and other French ships of war at the time the Anglo-French fleets proceeded to the Baltic on the outbreak of hostilities with Russia; but it never attained a reputation superior, if equal, to that of our common Admiralty pattern screw. It required a less aperture, however, in ships' sterns when necessarily lifted. Other advantages were also claimed for it by its advocates. The weather was in the highest degree favourable for developing the power of any propeller, the wind being light and the water perfectly smooth. The draught of water by the ship was within one inch of the previous day aft, and the same forward, being 20ft. 2in. aft, and 21ft. 9in. forward. On clearing the harbour channel the ship at once proceeded to the trial ground, and six runs were made at the measured mile. The time and speed were respectively—in the 1st, 5 minutes 9 seconds, 11·650 knots; in the second, 5 minutes 66 seconds, 10·714 knots; in the 3rd, 4 minutes 55 seconds, 12·203 knots; in the 4th, 6 minutes 2 seconds, 9·944 knots; in the 5th, 4 minutes 36 seconds, 13·043 knots; and in the 6th, 6 minutes 9 seconds, 9·756 knots. In the 5th and 6th runs the number of revolutions were 53½, in the others 53. Mean speed of the whole, 11·331 knots. At the conclusion of the run at the measured mile the ship was taken off to a fitting position, and her time ascertained in making a complete circle with the helm to port and also to starboard, the time being taken from the moment of giving the order. The same number of men (five) were at the wheel as were there on the previous day. The helm was first put hard a-port, and the rudder was hove over to an angle of 13¾ degrees in 28 seconds. The circle was completed in 7 minutes and 14 seconds. The helm being next put to starboard, the rudder was hove over to an angle of 15½ degrees in 30 seconds, and the circle completed in 7 minutes and 1 second. The engines during the time of making both circles averaged 52 revolutions. It will be seen, therefore, by comparison with the trial of the Admiralty pattern, or common screw of the previous day, that the Mangin screw obtained a slight advantage, but very slight, certainly, in point of speed, and that the ship also came round in less time then she did on the preceding trial. Both these apparently slight advantages were fully accounted for by the peculiarly favourable conditions of wind and weather under which the Mangin screw was tried. On the other hand the Mangin communicated to the ship a far greater vibratory motion than did the common screw, had an unusually violent "beat" in its revolutions through the water, and raised a column of water beyond what is usual in the screw well. On Monday, the 19th ult., the trial was resumed with a common screw having the corners cut off, but the speed realised was less than that attained during either of the previous trials, being 11·68 knots. There was, however, less vibratory motion than that experienced during the run with the Mangin screw, but rather more than is felt with the common Admiralty pattern. Six runs were made at the measured mile, and the machinery worked satisfactorily. Trials will now be made with a four-bladed and a six-bladed screw.

THE "COQUETTE," screw gun vessel, made her official trial of speed, with full and half boiler power, at the measured mile, in Stokes' Bay, on the 1st ult.:—She drew 11ft. 6in. of water aft, and 10ft. 8in. forward; carrying a Griffith's propeller with a diameter of 11ft. 11in., a pitch of 7ft. 6in., and an immersion of the upper edge of 1ft. 6in. The engines are of 200 horse-power, nominal. Six runs were made with full boiler power, the mean of the whole being 10·657 knots. With half boiler power four runs were made, which gave a mean speed of 7·767 knots. The temperature ranged in the engine-room from 75 to 85; in the fore stoke-hole it reached a maximum of 119, and in the after stoke-hole, a maximum of 85.

NAVAL APPOINTMENTS.—The following have taken place since our last: C. A. Shatford, Engineer, confirmed in the *Medea*; H. White, Acting Second-class Assist. Engineer, to the *Asia*, as supernumeraries; G. Deans, in the *Coquette*, confirmed as Engineer; G. Batchelor, Acting Engineer, from the *Indus* to the *Fisgard*; E. Williams, in the *Coquette*, confirmed as Second-class Assist. Engineer; D. Langland, in the *Impérieuse*, and C. D. Lacy, in the *Asia*, confirmed as First-class Assist. Engineers; A. Kedward and W. Strachan, in the *Impérieuse*, confirmed as Second-class Assist. Engineers; H. M. Crocker, Acting Second-class Assist. Engineer, to the *Indus*, as supernumerary; J. Hill, Acting Engineer, from the *Asia*, to the *Fisgard*, as supernumerary; W. C. Archbold, of the *Defence*, and J. B. Warrington, of the *Mullet*, confirmed as Second-class Assist. Engineers; H. Harrison, in the *Edinburgh*; E. W. Thomas, in the *Sheldrake*; C. Platt, in the *Marlborough*; C. McKeever, in the *Majestic*; W. H. Nicholson, in the *Narcissus*, for the *Penguin*; J. Bradbury, in the *Dauntless*, for the *Leveret*; and J. Swansea, W. Murray, and T. Carline, in the *Agamemnon*, promoted to First-class Assist. Engineers; A. McFarlane, Chief Engineer, to the *Fisgard*, for the *Vesuvius*; R. W. Hulford, First-class Assist. Engineer, to the *Fisgard*, as supernumerary; J. Ferguson and W. B. Trenwith, Second-class Assist. Engineers, to the *Forte* and *Russell* respectively; J. Fox, confirmed as Engineer in the *Tribune*; E. J. Humphreys and J. A. Raven, Acting Second-class Assist. Engineers, to the *Indus*; A. McFarlane, to the *Vesuvius*; J. Lear, Chief Engineer, to the *Galatea*; R. Tuplin, Engineer; J. Turner and W. E. Presgrave, First-class Assist. Engineers; A. Brown, Second-class Assist. Engineer; and C. S. Jordan, and J. H. Ferguson, Acting Second-class Assist. Engineer, to the *Galatea*; H. Harrison, First-class Assist. Engineer, and E. Miles, Acting First-class Engineer, to the *Vesuvius*; J. Ambler, First-class Assist. Engineer, to the *Indus*, for the *Gleaner*; J. W. Smart, C. F. Hulford, W. A. Betts, and J. Mitchell, Acting Second-class Assist. Engineers, to the *Cumberland*, as supernumeraries; R. G. Foster, Acting Second-class Engineer, to the to the *Edinburgh*; H. Brown, promoted to Chief Engineer; W. H. Wivil, First-class Assist. Engineer, to the *Royal Adelaide* for the *Princess Alice*; G. Thomson and J. H. Bradshaw, in the *Donegal*, confirmed as Second-class Assist. Engineers; J. H. Ferguson, confirmed as Second-class Assist. Engineer, in the *Galatea*; R. Ditchbourn, First-class Assist. Engineer, to the *Asia* as supernumerary; W. Town and J. Dunlop, Assisting Second-class Assist. Engineers, to the *Adventure*, as supernumeraries; R. J. Wemps, confirmed as Chief Engineer; W. Simlay, promoted to Acting Chief Engineer in the *Wrangler*; R. Phillips, confirmed as Second-class Assist. Engineer in the *Bacchanite*; T. S. Gissing First-class Assist. Engineer, to the *Asia*, for the *Fancy*; C. F. Gregory, Second-class Assist. Engineer, to the *Indus*, for the *Princess Alice*; W. Rumble, Inspector of Machinery, to the *Cumberland*; H. R. Gair, Engineer, to the *Cormorant*; W. Hardie, Engineer, to the *Racehorse*; W. Skeen, Acting Engineer, to the *Asia*, for the *Earnest*; W. G. Hughes, G. F. Williams, W. Berks, J. Baptist, and A. Martell, First-class Assist. Engineers, to the *Fisgard*, *Cormorant*, *Racehorse*, *Cracker*, and *Asia*, respectively; W. Crow, Acting First-class Assist. Engineer, to the *Fisgard*, as supernumerary; J. Templeton, Second-class Assist. Engineer, to the *Racehorse*; R. Findlay and T. W. Dearden, Second-class Assist. Engineers, to the *Cormorant*; J. S. Pidgeon, Acting Second-class Assist. Engineer, to the *Racehorse*; G. Alexander and J. Crichton, Second-class Assist. Engineers, to the *Colossus* and *Emerald*, respectively; C. A. Dewar, promoted to First-class Assist. Engineer, in the *Princess Charlotte*; J. A. Dicks, confirmed as Second-class Assist. Engineer, in the *Cumberland*.

LAUNCHES.

THE "LOMBARDIAN," screw steamer, has been lately launched from the building-yard of Messrs. Palmer Brothers, of Jarrow. At her trial trip, she averaged a rate of 13 knots per hour. She is intended to convey mails from Genoa to Sicily and Sardinia, and is also fitted up for a large number of passengers. Her length is 195ft., and registered tonnage 500. She is propelled by engines, also made by Messrs. Palmer, of 120 H.P., indicating an actual power of 500 horses.

LAUNCH OF THE "CLYDESDALE."—On the 22nd April there was launched from the Cessmock Bank Iron Shipbuilding-yard, Glasgow, by Messrs. J. and G. Thomson, a beautiful screw steam vessel named the *Clydesdale*, owned by the firm of Messrs. D. Hutchinson and Co., of the above city, and intended for the West Highland trade, as a consort to the *Clansman* built by the same firm. The *Clydesdale* mensures 175ft., keel and fore rake; 24ft. beam; and 13ft. 9in. depth of hold; tonnage, B.O.M., 500 tons. The engines are on the inverted cylinder principle, direct acting of 100 H.P. (nominal); diameter of cylinders 40in.; length of stroke, 2ft. 6in.; fitting with surface condensers, and all the most recent improvements. The *Clydesdale* is schooner rigged, clipper bow, demi female figure-head, and from the beautiful lines there is no doubt but the vesse will prove a fast and comfortable one.

On the 14th ult. Messrs. John Laird, Sons, and Co. launched from their yard at Birkenhead a finely-modelled wooden screw steamer of about 600 tons, built as a government dispatch boat for the Spanish government. The launch was very successful. Messrs. Laird and Co. are constructing the engines for the vessel.

On the 17th ult. there was launched from the iron shipbuilding yard of Messrs. Harland and Wolff, Queen's Island, Belfast, an iron screw steamer of 1000 tons register named the *Castilian*—the ninth steamer built by this firm for Messrs. Bibby and Co., of Liverpool. The *Castilian* is intended for the cattle trade in the Mediterranean.

On the 14th ult. Messrs. H. M. Lawrence and Co., of the Sandon Works, Liverpool, launched an iron paddle-wheel steamer called the *Mayflower*, and intended for service at the Wellesley ferries. The *Mayflower* is an improvement on the style of boat hitherto constructed in this country, and is a partial adoption of the American style. The *Mayflower* is 135ft. in length, 20ft. beam, and 8ft. in depth. Her engines are two oscillating cylinders, 34in. in diameter and 3½ft. stroke, of the collective power of 70 horses. The vessel's draught loaded will only be 3ft. 6in.

On the 14th ult. two steamers were launched from Messrs, Samuelson and Co.'s ship building yard, Garrison-side, Hull. The first of these was the *Neptune*, which has been built for Mr. Z. C. Pearson. The following are her dimensions:—Length, 204ft.; breadth of beam, 28ft. 6in.; depth of hold, 16ft. 6in.; tonnage, 990 tons O.M.; gross register, 688 tons. She is to be fitted with inverted engines of a superior description, with an aggregate of 80-horse power. The *Neptune* is sister ship to the *Lodona*, built by Messrs. Samuelson for the same firm a few weeks ago.—The other vessel which was launched from the same yard is a powerful steam paddle tug, named the *Reliance* built for the New Steamtug Company, of Liverpool. Length, 125ft.; breadth of beam, 24ft.; and of 80 H.P.

RAILWAYS.

CANADIAN RAILWAYS.—There were sixteen different railways in operation in 1861, making 1881 miles in Canada, and 227 miles of extension into the United States—to Portland and Detroit; in all, 2108 miles of railway. There is no double track, but 249 miles of sidings, or 10½ per cent. of the main lines. There were 112 miles in the course of construction. The Great Western has 445 miles; the Grand Trunk, 1092; the Buffalo and Lake Huron, 162; the Northern, 95; Montreal and Champlain, 72; Port Hope, 56¾; Cobourg, 28; Ottawa and Prescott, 54; and Brockville and Ottawa, 63½ There are 840 bridges, of which 672 are wooden, 147 of iron, 11 of brick or stone, and 10 swing bridges—making 94,361ft. of bridges, or about 48 miles in all. The total amount expended upon Canadian railways up to the end of 1860, was, in round numbers, 97,000,000 dols., and the average cost per mile, 19,218 dols. The amount of capital stock paid in on all the railways is over 38,000,000 dols. The total earnings of all the roads were 6,722,666 dols. for the year; total expenses, 5,675,500 dols. The average cost of repairing engines and cars per mile, was nearly 8 cents; average cost of repairing the permanent ways and works, was nearly 17 cents per mile; and the average cost of fuel was 6 cents per mile. The average speed of express trains was 24 miles per hour; and of freight trains, 13 miles per hour. There were 394 engines on all the roads, 57 of which were built in Canada; 229 in the United States; and 109 in Great Britain. The Great Western has cost over 25,000,000 dols. The total expenditure of the Grand Trunk up to Dec. 31st, 1860, was 69,998,950 dols. The cost of the Victoria Bridge was 6,599,300 dols.

CREAMER'S RAILWAY BRAKES.—These brakes, invented by Mr. Creamer, of New York, have been tested with very satisfactory results on the South Eastern Railway, where they have been adopted to a considerable extent. The brakes are applied by the force with which stout springs, previously coiled. unwind themselves when a catch is disengaged. In some recent experiments, with an engine, tender, and sixteen carriages, weighing about 143 tons in all, the train, when running at the rate of 50 miles an hour, down an incline of 1 in 100, was stopped in thirty seconds, and in a distance of 373 yards. When ascending a gradient of 1 in 664, at the rate of 36 miles an hour, the train was stopped in sixteen seconds, and in 133 yards.

MADRAS RAILWAY.—The report of the Madras Railway directors states that they may now congratulate the shareholders on the completion of their main or south-west line, 406 miles in length, from Madras to Beypoor. During the half-year ending the 31st of

December last, the opening of additional sections increased the mileage of this line under traffic to 271 miles. The 1st of April was fixed for opening 65 miles more, and on the 1st of May it was intended to open the remaining intermediate portion of 70 miles, thus completing the 406 miles from coast to coast. Of the north-west line 27 miles are now open for traffic, and a further opening will take place in the course of the year. During last year 1,124,817 passengers were carried on the company's lines without the occurence of any accident. The works on the Bangalore branch were proceeding satisfactorily. The capital account shows that £5,020,516 had been received, and £3,192,873 expended, leaving a balance of £1,827,642. The interest account states that £917,126 had been received from the Government for guaranteed interest, and that £93,899 of net revenue had been paid by the company to the Government in reduction of the advances for guaranteed interest.

THE LONDON AND NORTH WESTERN proprietors have resolved to lease the Cromford and High Peak Railway, thirty-one miles long, now one of the most primitive channels of communication in the kingdom. The rails are of cast-iron, which are to be replaced with rolled bars.

COAL-BURNING LOCOMOTIVES.—A fact of considerable interest was stated at the annual meeting of the Northern of France Railway Company. The consumption of coke, which eight years since amounted to 97 per cent. of the combustible consumed, is now reduced to 31 per cent., and is expected to be still further reduced this year, in consequence of the delivery of some locomotives designed to burn coal only. The consumption of coke has also fallen off on the other French railways, so much so, indeed, that the Northern has carried much less coke to Paris of late. The Northern has now got some engines capable of drawing 600 tons.

RAILWAY ACCIDENTS.

ACCIDENT ON THE LONDON, CHATHAM, AND DOVER RAILWAY.—The regular morning mail-train left the Victoria-station at its appointed time—7.10, and consisted of an engine and tender; there were attached two second-class carriages, followed by two first-class carriages, and terminating with a break van. The train, which was in charge of two guards and an experienced driver and fireman, proceeded safely on its course and arrived at and departed from Sittingbourne-station at the exact time, leaving the station for its downward progress to Dover at 8·26, which was correct time, and having no other stoppage to make until it arrived at Faversham junction at 9.10. The train then went on its journey until it reached a spot situated about half-a-mile from the Preston junction, which portion of the line is on an embankment known as the Ospringe-place bank, and is a little over twelve feet high, with a very mild curve and level. On reaching this spot, the train travelling at a moderate speed, the engine-driver felt a slight bumping movement, and in less than a second, on turning round, he saw that the back portion of the train was being hurled down the embankment. It was then ascertained that several of the passengers were severely injured, and two killed.

ACCIDENT ON THE LONDON AND NORTH WESTERN RAILWAY.—On the 5th ult. the boiler of a locomotive engine attached to an up goods train, which had just arrived at Harrow station, exploded with a fearful report, causing instantaneous death to the engine-driver, and frightfully injuring the stoker, who was brought to London and conveyed to the University Hospital in a condition almost hopeless. No positive information could be obtained as to the cause of the catastrophe.

ACCIDENT ON THE NORTH BRITISH RAILWAY.—An accident occurred on the 3rd ult. on the North British Railway, near St. Boswell's. It appears that as the train leaving Edinburgh at 3.45 p.m. for Kelso was proceeding between Newtown and Maxton, the carriages, eight in number, including the guard's break-van, left the rails, and the last six broke their couplings from the others, and were precipitated down the railway bank, about fourteen feet in depth. It was found that one passenger in the foremost second carriage, was killed, and several others severely injured.

FALL OF A RAILWAY BRIDGE AT HARROGATE.—A large stone bridge on the new line of railway, now in course of construction through Harrogate by the Great Northern Railway Company, has fallen without a moment's warning; causing serious, if not fatal, injuries to workmen engaged upon and beneath it. The bridge consisted of three arches, the central arch having a span of 40ft., whilst the one on either side is for foot passengers only. The bridge has been built to enable a landowner to open a carriage road from High to Low Harrogate through his estate. The buttresses are of stone, and the arches of red brick, cemented together. Ballast and other trains had passed over the bridge without any indication of its giving way; and though, in the opinion of many persons, the crown of the arch looked too flat, there was no apprehension of an accident. The workmen had commenced removing the centres or supports beneath the arches, and at least one ballast train passed over the bridge without any appearance of giving way. Just as the last prop was being removed, an engine, tender, and train of empty waggons arrived at the bridge and proceeded to cross it. The engine and tender crossed in safety, when the whole arch, without the slightest warning, fell in, leaving two empty trucks standing upon the permanent rails. At the time a dozen men were working under the arch, and several were employed on the top of it. Those upon the bridge were sadly injured. The cause of the accident is variously given. By some it is attributed to the crown of the arch being too flat; by others, to the removal of the supports before the cement was set hard; and by others, to the foundation of the buttresses being insufficient and insecure.

MILITARY ENGINEERING.

A 1000-POUNDER CANNON.—Capt. Rodman has made the following report to the War Department of the United States:—The entire success which has attended the manufacture and trial of the 15-inch gun, leaves no doubt of our ability to make reliable guns of even greater diameter of bore than 20in., and to manœuvre and load with facility, and without the use of machinery, guns of that calibre. A 20in. gun, one calibre thick, 210in. length of bore, and 20ft. total length, would weigh about 100,000lbs. A solid sphere of iron, 20in. diameter, would weigh about 1000lbs. A shell 20in. exterior diameter, 6·66in. thick. would weigh about 925lbs. The ordinary service shell need not be over 3·5in. thick; would weigh about 725lbs., and contain about 38lbs. of powder, making the total weight of the loaded shell about 763lbs. Shells only three inches thick may be fired without danger of breaking in the gun; they would weigh about 657lbs. each, and contain about 48lbs. of powder, giving the weight of the loaded shell about 705lbs. Adopting the same method of loading as for the 15in. gun, nine men, four at each end of the handspike, would load this gun with nearly the same facility that five did the 15in. gun; and seven men could load it. The charge of powder to impart the ordinary velocity to one of these shells would be about 100lbs. The living force of the service shell would equal that of six 10in. solid shot, and that of the battering shell would considerably exceed that of seven 10in. solid shot; and the destructive effect of such shells, compared with 10in. shot, upon iron-clad ships and floating batteries, would be in a much higher ratio; their whole crushing force being brought to bear upon a single point at the same time, while that of the smaller shot would be unavoidably dispersed, as regards both time and point of impact. While, therefore, fully recognizing the principle that the destructive effects of projectiles upon a strongly resisting object, increases in a higher ratio than as their calibres, and having no doubt that reliable guns of larger calibre may be readily made, yet, from the fact that 20 inches is about the largest calibre that can be readily loaded and manœuvred, without resort to machinery, and because it is not deemed probable that any naval structure, proof against that calibre, will soon if ever be built, I propose 20 inches as the calibre next to be tested.

EXPERIMENTS have recently been made at Shoeburyness to show that the iron sheild invented by Captain Inglis, Royal Engineers, is sufficiently effective as to resist the shot from the most powerful ordnance yet introduced. This shield is composed of strong wrought-iron planks, crossing each other in alternate layers, and by this means any degree of strength can be obtained for a permanent work of fortification or defence. The shield has been fired at from a range of 200 yards, with 68 and 110-pounders, without the least effect; and it also remained intact after an attack from Sir W. Armstrong's 300-pounder, which threw a shot of 156lbs.

TRIAL OF ARMOUR PLATES.—Some interesting firing with the 68-pounder smooth-bore took place on the 15th, 16th, and 17th ult., from the *Stork* gunboat, at armour-plates on the side of the *Sultan* target-ship, at Portsmouth. With one exception no armour-plates previously tested at Portsmouth, whether experimentally as targets, or merely for testing purposes, have exceeded 4½in. The exception alluded to was in the instance of Mr. Jones's angulated target, one-half of which was plated with 5½in. plates. The plates fired at in Portsmouth Harbour were all 5½in., and comprised one plate from the Mersey Steel and Iron Works, 15ft. long and 3ft. 4in. in breadth; and three plates from the Thames Iron Shipbuilding Company, Messrs. Brown, Atlas Works, Sheffield, and Messrs. Beale, of Parkgate Works, Yorkshire—each plate being 6ft. in length and 3ft. 3in. in breadth. Two hundred yards was the distance, and cast iron shot was used with 16lb. of powder. The Mersey plate received 14 shots, Brown's and Beale's 9 each, and the Thames Iron Company's 10. The timber backing, or ship's side, behind the last three was not penetrated. All the plates were of course broken, but all were of a superior quality, and all proved, by the manner in which they stood the pounding of the 68-pounder, that the additional inch of iron added to the resisting power sufficiently to compensate for the additional weight of armour, about 40lb. per square foot. There is one other important feature worthy of notice. The latest trials of armour-plates have satisfactorily demonstrated that great improvement has been made in the all-important matter of welding rolled plates within the last 12 months. The greatest and most active agent in the destruction of all armour-plates, however perfectly they may be manufactured, or however costly the material, are the bolts by which they are at present fastened to their ships' sides. All fractures from sound plates, on being struck by shot, spring from or to a bolt hole, and a fracture once started in a plate, the destruction of the latter becomes merely a question of time, dependent upon the quality of the iron used in its manufacture.

On the 19th ult. the Board of Admiralty and the Iron-plate Committee attended at Shoeburyness to witness some experiments to be made against an iron target proposed by Messrs. Samuda as a model for the construction of armour-plated ships. The peculiarities of this target are—first, that the wooden lining, which in the *Warrior* is interposed between the armour and the iron skin and framework of the ship is dispensed with; and, secondly, that the armuur-plates are so attached to the body of the ship as to contribute to its strength instead of merely hanging upon it. The armour plates in this case are five inches thick, and they are incorporated with an iron backing of plates and ribs which are equivalent to an additional layer of two inches thick, making altogether seven inches of iron. The target was subjected to the usual number of rounds of shot and shell from 100-pounder and 68-pounder guns, and the effects were much the same as were produced on similar targets proposed by Mr. Fairbairn, and lately tried at Shoeburyness. One round was then fired at it from the 300-pounder Armstrong gun, with 50lb. of powder. The shot struck an uninjured part of the target, and passed completely through, carrying with it large pieces of the iron, which were driven deep into the bank behind the target. The same gun was then fired once more against the old *Warrior* target, which in this instance in some degree reasserted its former supremacy. The shot passed through the armour, but only bulged and cracked the inner skin and framework. No fragment of the shot got got through the entire target. The extraordinary efficacy of wood thus applied as a stratum between the armour and the body of the ship is now rendered more apparent than ever. The armour-plate breaks the shot as it passes through and the wood arrests the fragments. It remains to be ascertained what will be the effect when a wrought iron shot, which will not break in striking, is substituted for the present cast-iron shot.

THE IRON PLATE COMMITTEE on the 23rd ult. attended at Shoeburyness to try a target proposed by Mr. Scott Russell. In this target the armour plates are attached by a new method, which obviates the use of bolts. The thickness of the plate is 4½in., but they are supported behind by other plates and ironwork, which alone are equal to a stratum almost as thick as the armour, so that the total thickness of iron is little short of 9in. No wood is used, but from the great thickness of iron its weight considerably exceeds that of the *Warrior* target. After sustaining the usual battering from 100-pounders and 68-pounders, three shots were fired against it from the 300-pounder, charged of 50lb. of powder. These three shots were each directed against an uninjured part of the target. The first and second shots lodged in the target, and the third went completely through. The mode of attaching the plates seemed very effective, but the resisting power of the target, its great weight taken into consideration, was deemed inferior to that of the *Warrior*. A crack had been previously discovered in one of the external coils of the 300-pounder, but was not thought sufficiently serious to prevent the gun being used. The crack from its rusted state does not appear recent, and it is supposed to have originated at the proving, which was very severe.

BOILER EXPLOSIONS.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.—At the ordinary monthly meeting of the Executive Committee of this Association, held at Manchester on Tuesday, April 29th, 1862, Mr. L. E. Fletcher, chief engineer, presented his monthly report, of which the following is an abstract:—"During the last month there have been examined 363 engines and 563 boilers. Of the latter, 10 have been examined specially, 8 internally, 87 thoroughly, and 458 externally; in which the following defects have been found:—Fracture, 14 (3 dangerous); corrosion, 47 (5 dangerous); safety-valves out of order, 18 (1 dangerous); water guages ditto, 8; pressure guages ditto, 8; blow-off cocks ditto, 33; fusible plugs ditto, 4; furnaces out of shape, 6 (3 dangerous): Total, 138 (12 dangerous). Boilers without glass water guages, 5; without pressure guages, 22; without blow-off cocks, 15; without back pressure valves, 42. Four explosions, which have occurred that were not under the inspection of this Association, have come to my knowledge, from three of which loss of life has resulted. The latter of these explosions occurred at an iron works, to a vertical boiler, heated by the flames from four iron furnaces. These flames first played upon the lower part of the outside of the boiler, and then passed through four openings in the side into an internal descending flue in the centre, and thence to the chimney. The boiler was cylindrical and egg-ended, and precisely similar in general arrangement to that first described in last month's report, being technically termed an upright furnace boiler. Its height had been about twenty-seven feet, and its diameter ten feet, while the thickness of the plates had varied in the original construction from five-sixteenths to seven-sixteenths. Its age was about nine years, and its working pressure, although stated by the engine attendant to have been 35 lbs., was concluded from an examination of the safety valves, &c., on an official inquiry at the instance of the coroner, to have been not less than 50 lbs. The percussive force of the steam had destroyed the adjacent iron furnaces, and unseated, as well as denuded of its surrounding brick flue, a twin-vertical boiler, which had previously worked in conjunction with the one in question, being connected to it by a common steam-pipe. There are grave objections to the construction of this boiler, as well as to the mode in which it was set. The intense flames from the furnaces by which it was heated, impinged most severely upon the lower part of the external shell, the diameter of which, being not less than ten feet, was of unusual size, while, in addition, the water was sedimentary."

Fatal Boiler Explosion.—On the morning of the 20th ult., at a few minutes before six o'clock, one of the boilers at the large iron ship-building works of Messrs. Scott and Co., of Greenock, exploded, killing one man and dangerously injuring at least twelve more. The part of the works in which the boiler was situated is a mass of ruins.

DOCKS, HARBOURS, CANALS, &c.

The Suez Canal.—The gigantic works in connection with the Suez Canal scheme are being pressed forward with a vigour worthy the undertaking. The Egyptian Government have furnished a great number of hands for the service of the company—in fact, nearly 22,000. It must not be imagined, however, that these comparative slaves will exert themselves as would as many English or French labourers. The intention is to employ double that number, if they can be got from Egypt. At present, the work is almost exclusively concentrated upon the cutting to be made upon the sand heights of El Djiser, and the engineers promise that what they call the *rigole de service*, or elementary canal, shall within the next two months carry the waters of the Mediterranean into the basin of Lake Tismah. This canal, or cutting, as we should prefer calling it, will be about 15ft. wide, and 18in. deep. Some twenty dredging machines are to be employed in clearing out a channel, which, completed last year, has realized the prophecy of the late Robert Stephenson, and now become choked by sand. There is no doubt that the company have undertaken a task which it will require all the talent of their engineers, and all the muscular force of their 40,000 assistants to accomplish.

ACCIDENTS TO MINES, MACHINERY, &c.

Fatal Coal Pit Accident at Twerton. — An accident, attended with fatal consequences, lately happened at the coal pit situated at Pennyquick, Twerton, belonging to Messrs. Carr, but worked by the firm of Brown and Co. About six o'clock, the time of leaving work, four men and a lad got into the cage at the bottom of the shaft, for the purpose of being brought to bank. As the cage ascended, one of the men, in some unaccountable manner, got his head entangled in the connecting portion of the signal wire running up the shaft, and as the cage was drawn up, his chin was forced down on the edge of it, and before the engineer could be called on to stop the ascent of the cage, the unfortunate man's head was nearly severed from his body. When brought to the surface, he was quite dead. It is surmised that the signal wire must, by some means, have become displaced.

MINES METALLURGY. &c.

Treatment of Copper and Silver Ores.—Some improvement in the mode of extracting the copper and silver from the ore containing them have recently been patented by Prof. Dr. Bischof, of Bonn and Mr. Gustav Bishof, of Swansea. When the ores contain lime as gangue they are calcined in an ordinary lime-kiln, and the product is then washed, to remove the fine particles of hydrate of lime and magnesia. The washed calcined ore is treated according to its composition. If the metal does not require this calcining and washing, it may be at once mixed with iron pyrites and smelted. The product (coarse metal) is then pulverised and calcined at a low red heat, in a muffle heated externally, provision being made for the passing away of the gases and vapours, and for the supply of atmospheric air to the matters being calcined. By these means the sulphide of copper will, for the most part, be converted into sulphate, which is to be lixiviated with water. The residue, after dissolving out the copper, is treated with dilute sulphuric acid, by which the oxide copper will be obtained in solution, and, if there be not much antimony and arsenic the silver present will also be obtained in solution. When there is much antimony and arsenic the residue must be calcined at a higher temperature, mixing the product with pulverised bituminous coal, and with iron pyrites or coarse metal, sulphate of copper or aluminite, or sulphide of zinc. The product obtained by this calcination is to be lixiviated in the resulting wash-waters of the lixiviating process, by which the remainder of the silver will be obtained in solution. If the ore does not contain silver, then the second process of calcination will be unnecessary. In some cases raw copper ore is mixed with aluminite, and the mixture calcined in a muffle, as before described and in like manner silver ores may be treated with or without aluminite. The copper and silver thus obtained in solution are precipitated in the usual manner, and to facilitate precipitation vertical stirrers, or rakes, of wood are used, or, in place of employing the ordinary means of precipitation, calcined carbonate of magnesia is used to throw down the copper. The copper obtained from the solution is washed with a dilute solution of sulphate of copper to remove the metallic iron afterwards with water, and then with an alkaline solution, to remove the basic sulphate of peroxide of iron; the copper is then roasted, to remove metallic antimony and arsenic, and then smelted.

APPLIED CHEMISTRY.

Chloride of Lime as an Insecticide.—In scattering chloride of lime on a plank in a stable, all kinds of flies, but more especially biting flies, were quickly got rid of. Sprinkling beds of vegetables with even a weak solution of this salt effectually preserves them from the attacks of caterpillars, butterflies, mordella, slugs, &c. It has the same effect when sprinkled on the foliage of fruit trees. A paste of one part of powdered chloride of lime and one-half part of some fatty matter, placed in a narrow band round the trunk of the tree, prevents insects from creeping up it. It has even been noticed that rats and mice quit places in which a certain quantity of chloride of lime has been spread. This salt, dried and finely powdered. cah, no doubt, be employed for the same purposes as flour of sulphur, and be spread by the same means.

On the Preparation of Caustic Soda, by M. Woehler.—This process consists simply in calcining nitrate of soda with peroxide of manganese. No chameleon is formed, as might be supposed, since the nitrate decomposes long before the mixture can reach the temperature necessary for the production of manganic acid.

On the Detection of Bromine, by M. Fresenius.—According to M. Balard, the best vehicle for dissolving bromine just displaced by chlorine is sulphide of carbon, a process long used in France for detecting iodine. M. Fresenius, who has verified this fact with his usual care, insists on the necessity of avoiding excess of chlorine, and of employing sulphide of carbon free from sulphurous and sulphuric acid. His preference for sulphide of carbon over ether and chloroform is founded on a series of direct experiments with standardsolutions containing various proportions of bromides. Solutions containing only $\frac{1}{30000}$th of bromine in the state of bromide of potassium, when treated with the requisite quantity of clhorine, do not communicate the least colour to ether or chloroform, while sulphide of carbon acquires a decided yellow tint. This vehicle, then, answers best for this purpose. Moreover, being heavier than water, it sinks to the bottom of the liquid with the bromine it has dissolved, and there remains. If the bromide is accompanied by an iodide, the iodine must be previously eliminated by adding a little hyponitric acid and a drop of sulphide of carbon, which takes away the displaced iodine. After this the separation of the bromide may be proceeded with.

APPLICATIONS FOR LETTERS PATENT.

Dated April 25, 1862.

1206. S. C. Salisbury, Coventry—Sewing machines.
1207. F. Barnett, Paris—Electric danger signals for railways and other cognate purposes.
1208. G. Richards, 12, Caroline-street, Bedford-square—Ordnance, and the manner of loading such with the charges and projectiles suitable thereto.
1209. J. F. Brunet, 24, King William-street Strand—Fringes.
1210. R. C. Mansell, Ashford—wheels to be used on railways.
1211. P. R. Drummond, Perth—Revolving rake.
1212. J. T. Davies, Liverpool—Circuit horse powers.
1213. R. P. Roberts, 3, Exeter Villas, Kennington Oval—Preparation of paper for copying letters and other documents, and in the preparation of copying ink.
1214. J. Elder, Glasgow—Steam-engines and boilers.
1215. J. Shaw, Liverpool—Steam and other power engines and indicators.
1216. J. Aspinall, Middlesborough-on-Tees—Apparatus for the safe conveyance from sea to land of ships' papers, documents, money, and other valuables when wrecks or other casualties occur at sea.
1217. C. Reed, Kintbury—Method of treating the sorghum saccharatum or holcus saccharatus in order to obtain saccharine liquor and pulp therefrom.
1218. A. C. Kirk, Bathgate—Refrigerating apparatus.
1219. A. Applegarth, Dartford—Printing in colours and apparatus to be employed for this purpose.
1220. W. Hale, 6, John-street, Adelphi—Rockets.
1221. W. Fisken, Stamfordham—Apparatus for cultivating land by means of steam power.
1222. L. McLachlan, Manchester—Governiug light used for taking photographic portraits and other photographic pictures, which improvements is also applicable to lighting picture galleries.
1223. E. A. L. Negretti and J. W. Zambra, Hatton-garden—Mercurial minimum thermometers.
1224. W. E. Newton, 66, Chancery-lane—Chimnies for lamps.

Dated April 26, 1862.

1225. D. C. Le Souëf, Twickenham—Nails, bolts, rivets, screws, eyes. and split keys or pins.
1226. T. U. Brocklehurst, Macclesfield — Machinery for reeling singles, trains, organzines, and sewing silks.
1227. G. H. Law, Camden New-town—Draining flower pots and other articles or things which require draining in the same or a similar manner.
1228. J. G. N. Alleyne, Alfreton—Machinery and apparatus for the preparation and manufacture of iron and steel.
1229. E. Alcan, Coleman-street Buildings—Carding engines.
1230. W. Clark, 53, Chancery-lane—Collar, wrist bands, and cuffs.
1231. S. Cheavin and G. Cheaven, Boston, Lincoln—Filtering and purifying water, and in apparatus employed therein.
1232. F. G. Spilsbury and F. W. Emerson, Stratford, Essex—Treatment of fusee oil, and for various applications of the same to useful purposes.
1233. A. Boyle, and T. Warwick, Birmingham—Machinery for manufacturing hair pins and cottar pins, a part of which machinery may also be used for cutting off and pointing wires for various purposes.
1234. H. W. Hart, Higher Broughton, Manchester—Manufacture of reflectors and shades for gas and other lights.
1235. G. Bischof, jun., Swansea—Treating solutions containing copper and silver, or either of them, to obtain metallic copper and silver.
1236. G. H. Smith, North Perrott—Crinoline or elastic hoops for dresses.
1237. A. Lester, Coventry—Fronts or uppers of slippers, shoes, boots, and gaiters, and of mats, bags, fire screens, and various other articles which are usually made of ornamental or Berlin needlework
1238. A. V. Newton, 66, Chancery-lane—Hollow glass ware.
1239. A. V. Newton, 66, Chancery-lane—Lamps for burning coal oil and other hydro-carbons.

Dated April 28, 1862.

1240. G. B. Goodman, 59, Baker-street, Portman-square—Preventing accidents in or at mine shafts.
1241. J. Burnie, Castle-Douglass—Tobacco pipes.
1242. J. Fletcher, Southwark—Apparatuses for treating saccharine liquids.
1243. R. Vaile, Auckland, New Zealand—Propellers for ships and boats.

Dated April 29, 1862.

1244. W. T. Glidden, Massachusetts, U.S.—Restoring phosphatic guano.
1245. G. R. Samson, Kentish-town—Valves or cylinders for wind musical instruments.
1246. H. F. Wells, Woolwich—Cramps for joiners and other work.
1247. J. W. Caley and F. G. Caley—Silk textile fabric.
1248. J. E. A. Gwynne, Essex-street-wharves, Strand—Machinery for lifting, forcing, and exhausting, and in the application of the same.
1249. R. E. Dixon, New York, U.S.—A smoker's pipe and tobacco pouch.
1250. S. W. Newington, Goudhurst—Apparatus for letting-off and stopping the flow of liquids from casks and vessels, such apparatus forming a tap and substitute for the ordinary vent peg.
1251. E. Clark, 24, Great George-street—Arches.
1252. W. Clark, 53, Chancery-lane—Preserving animal and vegetable substances.
1253. J. Ross, 53, Chancery-lane—Grinding stones or surfaces for grinding grain and other substances.
1254. R. Bright, Bruton-street, Westminster—Lamps and in apparatuses for lighting Argand and other wicked lamps.
1255. J. Cliff, Lambeth—Insulators for supporting telegraph wires.
1256. W. L. Tizard, Mark-lane—Heating, cooling and condensing apparatuses.
1257. D. M. Childs, 481, New Oxford-street—Steam engines.
1258. D. M. Childs, 481, New Oxford-street—Reaping and mowing machines.
1259. D. M. Childs, 481, New Oxford-street—Means of changing a rotary into a reciprocating, and a reciprocating into a rotary movement in machinery.
1260. E. Wilson, 5, Parliament-street, Westminster—Machinery used in the manufacture of malleable iron and steel.
1261. W. E. Newton, 66, Chancery-lane—Machinery for picking, burring, and cleaning wool and other fibrous substances.
1262. W. E. Newton. 66, Chancery-lane — Mowing and reaping machines.
1263. M. Henry, 84, Fleet-street—Apparatuses for aerating liquids, and in fastenings for the said apparatuses and for other articles.

Dated April 30, 1862.

1264. E. Moore, Tewkesbury—Dress shirts and dresses.
1265. A. Travis, Dunkinfield—Engines for carding cotton and other fibrous materials.
1266. A. Mahon, Rathmines, Dublin—Projectiles.
1267. J. Harrington and T. Perkins, Birmingham—Mounting photographic portraits for visiting cards, and in mounting photographs in general.
1268. G. Davies, 1, Serle-street, Lincoln's-inn—Electric apparatus applicable to various useful purposes.
1269 G. Davies, 1, Scarle-street, Lincoln's-inn—Nails, screws, and other analagous articles in malleable cast iron.
1270. A. T. Mercier, Louviers, France—Weaving looms.
1271. J. Maiden, Waterloo, Ashton-under-Lyne — Safety lamps.
1272. E. Leigh, Manchester — Construction of ships and floating batteries, in mounting their guns, and in the application of steam power, parts of which improvements are also applicable to land batteries and forts.
1273. T. Piatti, Paris—Propulsion of ships and other vessels, and in the means and apparatus employed for this purpose.
1274. H. Hickman, Dalston—More securely fastening of ladies' crinoline skirts and other articles of wearing apparel, and also for the fastening of elastic and other bands.
1275. J. Oxley, Sheffield—Apparatus for cutting and chopping bread and other substances.
1276. G. H. Birkbeck, 34, Southampton-buildings, Chancery-lane—Couches or settees.
1277. J, M. Carter, Monmouth—Harness and the shafts of carriages.

1278. A. Prince, 4, Trafalgar-square, Charing-cross—Composition for casting to represent marble.
1279. W. Staufen, George-street, Portman-square —New material to be used in the manufacture of brushes, and also applicable to the purposes for which bristles, horse hair, and human hair are now used.
1280. J. L. Norton, Bell Sauvage-yard, Ludgate-hill—Apparatus for drying fibrous materials and yarns.
1281. J. M. Napier, York-road, Lambeth—Machinery for manufacturing projectiles.
1282. A. H. Fielden, 35, Castle-street, Holborn—Show jars, lamps, signals, and lighthouses, and other methods of illumination to be called the "Rainbow light."
1283. H. F. Broadwood, Great Pulteney-street—Pianofortes.
1284. H. Willis, Albany-street, Regent's-park—Valves for the supply and discharge of gaseous bodies.
1285. W. E. Newton, 66, Chancery-lane—Lamps.
1286. W. T. Loy, Rood-lane—Machinery for carding cotton and other fibrous substances of a similar character.

Dated May 1, 1862.

1287. J. Swallow and J. Allinson, Heckmondwike—Carpet fabric.
1288. W. B. Smith, Camborne, Cornwall, and W. Bennetts, Tucking Mills—Preventing the injurious effects occasioned by smoke, sulphur, and the deleterious gases which escape from stacks, chimneys, calcining houses, chemical and other furnaces.
1289. C. P. A. Douchain, St. Cloud, France—Apparatus for letting in or shutting off water or other liquids.
1290. T. Holmes, 15, Princess-terrace, Regent's-park — Military cartouches, portmonaies, courier bags, letter bags, knapsacks, and other articles of a like nature.

Dated May 2, 1862.

1291. W. and T. Huntington, Liverpool—Machinery for the manufacture of bread.
1292. H. Kohn, Berlin—Making many kind of stuffs, textures, or fabrics waterproof.
1293. W. Bodden and W. Mercer, Oldham—Certain parts of machinery for slubbing and roving cotton and other fibrous substances.
1294. T. F. Griffiths, Birmingham—Raising or shaping sheet iron.
1295. R. Walker, Glasgow—Malting, and apparatus therefor.
1296. O. C. Evans, Old Kent-road—Reversible attachment to a shaft or arbor for converting reciprocating rectilinear into rotary motion.
1297. O. C. Evans, Old Kent-road—Abdominal truss, intended for the more perfect support and cure of hernia.
1298. C. Ashwell, Barnsbury-park, Islington—Safety fastening applicable to the locks of doors.
1299. R. A. Brooman, 166, Fleet-street—Apparatuses for superheating steam.
1300. C. F. Whitworth, Sowerby-bridge, York—Apparatuses for signalling upon railways.
1301. M. Paul, Dumbarton—Windlasses and capstans or ships' winding apparatus.
1302. J. W. Gill, Woolfardisworthy, Crediton—Apparatus for turning up ahd pulverizing the soil of land for cultivation.
1303. H. Welch, Millwall—Securing or attaching armour plates on or to ships or vessels.
1304. A. V. Newton, 66, Chancery-lane—Electrical apparatus applicable to the lighting of gas.

Dated May 3, 1862.

1305. W. Mossman, 1, Cleveland-terrace, Gloucester-road—Bonnets, hats, or coverings for the head.
1306. J. Brierley, Blackburn—Construction of fire-plugs or valves to be used in extinguishing fires or for other purposes where water is required to be drawn from mains under pressure.
1307. H. Juhel, Bordeaux—Wheels.
1308. J. Tyler, 5, Kennington-place, Kennington-lane.—Clarionets.
1309. E. Omerod and C. Schiele, Manchester—Machinery for cutting or dressing stones, which are also applicable for hammering, crushing, or otherwise reducing metals, and other materials.
1310. H. G. Moffat, Dalston—Advertising mediums.
1311. J. M. Herdevin and J. A. Jullien, Paris—Sluice cocks.
1312. T. Snowdon, Stockton-on-Tees—Steel tyres, hoops, and cylinders, and furnaces employed therein, and applicable to the melting of steel generally.
1313. J. H. Heppel, 34, Great George-street, Westminster—Construction of the permanent way of railways.
1314. J. Herdman, Belfast—Manufacture of wrought-iron, steel, or combined wrought-iron and steel plates adapted for ship building and other purposes for which strength and lightness are required.
1315. W. Black, Northampton—Lottery and ballot-boxes.
1316. G. Neall, Islington—Obtaining and applying motive power.
1317. M. Henry, 84, Fleet-street—Process of and apparatus for preparing materials for the manufacture of paper, and in obtaining products from agents used in the said process, part of the said invention being also applicable to apparatus for washing.
1318. J. Fowler, Leeds—Engines for hauling agricultural implements.
1319. S. Merolla, Naples—Fire-arms.
1320. W. E. Newton, 66, Chancery-lane—Joining boxes.
1321. J. and T. Mellodew, Oldham, and C. W. Kesselmeyer, Manchester—Looms for weaving.
1322. C. Schlickeysen, Berlin—Machinery for moulding bricks, tiles, pipes, and turf.
1323. J. Heyworth, Shawforth, Rochdale—Looms for weaving.
1324. P. V. Lefebvre, Paris—Self-feeding pen-inkstand.

Dated May 5, 1862.

1325. A. Williams, New Windsor—Backed form or seat capable of being converted into a level table with seat or a desk either level or sloping or at any angle.
1326. T. Parkinson, J. Norman, and R. Cottam, Blackburn—Furnaces for steam boilers.
1327. L. F. Pereaux, Paris—Clocks or machines for keeping time.
1328. H. Allman, Bedford-row—Locks.
1329. T. Wilson, Birmingham—Covering ships of war and land batteries with armour plates, and construction and steering of ships of war.
1330. S. Barnett, Hoxton—Helmets for divers.
1331. T. Brindley, Finsbury—Travelling and other flasks, decanters, bottles, and other necked vessels.
1332. C. Binks, Parliament-street, Westminster—Obtaining hydrogen gas and certain gaseous compounds of hydrogen and of carbon.
1333. F. Marrel, Marseille—Wrought-iron bars for the manufacture of armour plates and other artices of forged iron.
1334. J. Victor, Wadebridge, J. Polglase, Bodmin, and W. Rounsevell, St. Breock—Safety fuses sor mining and other purposes.
1335. R. Burley, Glasgow—Arrangements for using ordnance under water, and in part applicable otherwise.
1336. R. Bushby, Little Hampton—Lifting or lightening ships for entering shallow harbours for docking and other purposes.
1337. J. Roscoe, Leicester—Lubricator for steam engines.
1338. P. Sourbé, Condom, France—Maturing sdirits and wines.
1339. E. Wilson, 5, Parliament-street, Westminster—Machinery used in the manufacture of malleable iron and steel.
1340. J. Johnson, 47, Lincoln's-inn-fields—Steam generators.
1341. J. Adcock, Dalston—Apparatus for measuring and indicating distances travelled by wheel carriages.
1342. B. Cooke, Devonport—Implement for cutting hair.

Dated May 6, 1862.

1343. T. Cabourg, Paris—Machines for the purpose of uniting together by means of screws leather used in the manufacture of boots and shoes, and other articles composed of two or more pieces of leather.
1344. R. Mills, Bury—Washing, wringing, drying, and mangling machines.
1345. A. Morel, Roubaix, France—Heckling machines.
1346. G. Borthwick, Bedford—Construction of ships and boats, and certain other floating bodies.
1347. P. Chenaillier, Paris—Apparatus for concentrating liquids, or for condensing alcoholic or other vapours.
1348. J. Clarke and J. Richmond, Chilvers Coton—Looms for weaving.
1349. W. and J. Richard, Edinburgh—Printing types, spaces, and quadrats.
1350. J. H. Johnson, 47, Lincoln's-inn-fields—Manufacture and production of minium or red lead.
1351. W. Greaves, Soho—Safety stirrup bars.
1352. J. H. Johnson, 47, Lincoln's-inn-fields—Manufacture of soda and potash, and of their carbonates.
1353. W. Clarke, 53, Chancery-lane—Buckle or fastening.
1354. W. Clarke, 53, Chancery-lane—Cylinder printing apparatus.
1355. J. E. Ransome, W. Copping, and L. Landsell, Ipswich—Harrows.

Dated May 7, 1862.

1356. W. E. Nethersole, Swansea—Railway trucks and wag-, gons, parts of which are applicable to railway carriages.
1357. W. Judson, New York, U. S.—Use of caoutchouc or india-rubber for, and its application to, guns, mortars or other fire-arms, to resist the force of the recoil and reaction in firing.
1358. E. Bourdon, Paris—Blowing fans, which improvements are also applicable to centrifugal pumps for raising water and other liquids or gases, or for exhausting the same.
1359. C. V. F. De Berville, Paris—Safety coupling bar for locomotive and other railway carriages.
1360. P. H. Colomb, Devonport—Arrangements and apparatus for signalling.
1361. T. Markland, Hyde—Wearing apparel.
1362. T. H. Hopwood, Hulme—Means or apparatus to be employed for the purpose of raising sunken vessels or other submerged bodies, and also in the application of a self-acting balance and regulator to the pontoons used therein.
1363. C. Clark, 361, City-road—Cigar tube.
1364. N. Wood, Hetton Hall, Durham, and J. Stockley, Newcastle-on-Tyne—Grinding, smoothing, and polishing plate glass.
1365. J. Johnson and A. Chapman, Leatherhead—Apparatus for preventing collisions on railways.
1366. R. A. Brooman, 166, Fleet-street—Box and apparatus for containing and igniting matches.
8367. R. A. Brooman, 166, Fleet-street—Swings.
1368. J. Combe, Leeds—Machine for spreading and drawing into slivers flax, hemp, jute, and other fibrous substances.
1369. G. T. Bousfield, Brixton—Applying steam power to tilling land by means of a digging locomotive.
1370. J. Haley, Battersea—Ships' boats and batteries.
1371. W. Gossage, Widness—Apparatus to be used in the manufacture of soap.
1372. D. Marchal and A. C. De Wiart, Brussels—Preventing the destructive effects of vibration or jar on the permanent way of railways, and on the wheels, axletrees, and other parts of carriages, and the working and other parts of machinery liable to shocks.
1373. J. McCann, Dublin—Drying, cooling, and cleaning grain.

Dated May 8, 1862.

1374. J. Hay, Troon—Cleaning and repairing ships' bottoms.
1375. W. P. Gaulton and Major Booth, Manchester—Apparatus for damping and steaming fabrics, part of which improvements are applicable for distributing fluids for distributing fluids for other purposes.
1376. W. Riddle, Islington—Hydraulic and other presses in packing machinery, and in treating cotton and other fibrous substances.
1377. A. Bearne, Torquay—Rendering the heels of boots, shoes, and goloshes elastic to pressure.
1378. W. Southwood, Kensington—Machinery for pulverising ores and extracting metals therefrom, part of which is applicable to breaking stones.
1379. J. Fowler, Leeds, and J. King, Chadshunt—Apparatus for tilling land by steam power.
1380. P. Tate, Kennington—Smelting furnaces.
1381. C. Lungley, Deptford—Manœuvring ships and vessels.
1382. G. C. Grimes, Wandsworth—Cigar lights, splints, matches, and tapers or vestas, and in machinery or apparatus employed therein.
1383. A. P. Price, 47, Lincoln's-inn-fields—Straps or bands for securing articles, parcels, or luggage.
1384. A. Kinder, 30, Cannon-street—Manufacture of sheet metal.
1385. L. De la Peyrouse, 13, Panton-square—Treating neutral and acid fatty or oily substances, resins, and resinous substances, and compounds or products containing paraffine.
1386. N. Thompson, Birmingham—Barometers.

Dated May 9, 1862.

1387. G. F. Greiner and J. H. C. Sandilands, Golden-square—Pianofortes.
1388. T. McIlroy, Canada West—Invalid bedstead.
1389. L. D'Aubréville, Paris—Metallic cross sleepers for the construction of railways.
1390. T. K. Mace, Birmingham—Guards or protectors for hats and other coverings for the head.
1391. W. Eddington, jun., Chelmsford—Portable grinding, chaff-cutting, and corn-crushing machinery.
1392. F. F. B. Mayall, Warrington—Dyeing mixed or plain fabrics and yarns.
1393. J. F. Bland, Dorset-square—Apparatus for signalling between targets and shooters.
1394. T. Fawcett, jun., Lisburn—Plaited fabrics for shirt fronts and other uses, and in the mode of and mechanism for manufacturing the same.
1395. J. Oxley, Frome—Apparatus for facilitating the processes of mashing and sparging in breweries and distillieries.
1396. T. Welton, 13, Grafton-street, Fitzroy-square—Preparation of beverages in connection with brewing.
1397. N. Symonds, St. Pancras — Wheels, framework, girders, columns, and stancheons, blades of blowing fans and paddle wheels for steam vessels.
1398. F. J. Bolton, Bolton-row, May Fair—Telegraphing for naval and military and other purposes.
1399. F. J. Bolton, Bolton-row, May Fair—Apparatus for displaying the lights in lighthouses.

Dated May 10, 1862.

1400. G. C. Haseler, Birmingham—Lockets.
1401. J. G. Willans, Belfast—Treatment of the product from iron blast furnaces (whether moulded or otherwise) usually termed pig or cast iron or castings.
1402. J. F. Milward, Redditch—Breech-loading fire-arms.
1403. W. Clark, 53, Chancery-lane—Application of a vegetable fibre alone or in combination with other matters in the manufacture of felted and other fabrics, also as a substitute for flock or powdered wool, and as a material for padding or stuffing and for other useful purposes.
1404. R. Moore, Cannon-street—Apparatus for indicating the presence, position, or accumulation of liquids, gases, or vapours, and apparatus for preventing danger or damage consequent thereon.
1405. R. Moore, Cannon-street—Structure and appliances of ships and other vessels.
1406. J. T. Cooke, Leicester—Battens used in weaving.
1407. R. Willoughby, Mildmay-road, Islington—Apparatus for exhibiting and giving rotatory and traversing motion to placards, and other objects.
1408. H. D. Taylor and E. Robinson, Huddersfield—Piecedyed wollen fabrics or fabrics composed of wool in combination with other fibrous substances.
1409. J. House, Market Lavington—Machinery for crushing or reducing substances.
1410. W. H. Ronald, Montrose—Apparatus for signalling and indicating the position of shots in rifle practice.
1411. E. Kolbenheyer, Vienna—Apparatus for making ices and cold beverages.
1412. J. B. Cristofini, Paris—Improved tent.
1413. W. Clark, 53, Chancery-lane—Lamps, and in apparatus for filling lamps with oil or fluid to be consumed.
1414. H. W. Sambidge, Birmingham—Sliding chandeliers, gasaliers, and other pendent lamps.

Dated May 12, 1862.

1415. H. Walker, Gresham-street — Making handles for crotchet needles, pencils, penholders, and other articles.
1416. J. Milner, Gloucester—Portable apparatus for exercising the human body.
1417. G. Fuhrmann, Paris—Melting and boring cast steel barrels, applicable to fire-arms and pieces of ordnance.
1418. W. Clark, 53, Chancery-lane—Smoke consuming fire-grates.
1419. J. B. Pope, Leeds—Apparatus for lowering and loading coals, minerals, or other substances.
1420. C. J. Harris, 20, King William-street, Charing-cross—Detector, season, or non-transferable tickets.
1421. H. S. Firman, Southwark—Apparatus for washing and cleansing textile fabrics or raw materials, and for forcing fluids or moisture from the same.
1422. J. H. Johnson, 47, Lincoln's-inn-fields — Casting metals, and in the moulds and cores employed therein.
1423. H. Bayley, Stalybridge, L. Newton, Oldham, and J. Greaves, Stalybridge—Machinery for turning, boring, cutting, shaping, and reducing wood and other substances applicable for the manufacture of various articles.
1424. H. Cartwright, Broseley—Propelling and steering screw steam vessels.
1425. W. N. Hutchinson, Plymouth—Screw propelled ships.
1426. C. J. Neale, High Oakham—Apparatuses for measuring or registering corn and other grain.
1427. H. Ashworth, Hyde—Machinery for opening and carding cotton and other fibrous substances.
1428. J. L. Wilson, St. John-street, Smithfield—Calendering woven fabrics, and in the apparatus employed for this purpose.
1429. A. B. Freeland, Upper Norwood—Treatment of hops.
1430. E. F. Lansky, Sheffield—Mode of and apparatus for working railway carriage brakes.
1431. T. Buckney, Peckham Rye—Portable "tell tale" time keepers.

Dated May 13, 1862.

1432. S. B. Ardrey, Birmingham, and S. Beckett, Oldham—Machinery for manufacturing spindles, part of which apparatus is also applicable to grinding and polishing other articles.
1433. J. Johnson, 47, Lincoln's-inn-fields—Carrying out submerged and other engineering works.
1434. J. D. Gavillet and J. P. F. Gandon—Paddle wheels applied either for propelling steam boats, or as prime movers.
1435. P. Lopez, Paris—Apparatus for sowing wheat or other grain or seeds.
1436. J. Sardy, New York—Ships of war and other vessels.
1437. W. Newton—Coffee pots and boilers for culinary purposes, part of which are also applicable for generating steam.
1438. A. Wormull, Old Fish-street — Trepanning instruments.
1439. G. Blake, Trowbridge—Apparatus for warming apartments.
1440. J. Johnson, 47, Lincoln's-inn-fields—Purification of colza, rape, and other oils.
1441. R. Boyd, Southwark—Manufacture of bacon.
1442. J. Sivenright, St. Helens—Manufacture of polished plate glass.
1443. W. Clark, 53, Chancery-lane—Apparatus for generating motion in fluids, applicable for raising and forcing water, propelling and otherwise in the distribution of motive power.
1444. W. Hartican, Brighton—Fire escape apparatus.
1445. R. Brooman, 166, Fleet-street—Apparatus for shunting trains.
1446. R. Brooman, 166, Fleet-street—Louvre blinds or shutters.
1447. W. Southwood, Kensington—Machinery for manufacturing nails from either hot or cold bars of irons or other metal.
1448. R. Latham, 71, Fleet-street—Steering apparatus.
1449. M. Henry, 84, Fleet-street—Gloves.

Dated May 14, 1862.

1450. C. Porter, New York—Steam engine indicators.
1451. H. Joubert, 18, Maddox-street—Raising a music chair, stool, or seat, which entirely supercedes the original screw now in use.
1452. F. Tolhausen, 100, Fleet-street—Velvets.
1453. R. Brooman, 166, Fleet-street—Method and apparatus for the production of photographic and stereoscopic portraits and pictures.
1454. J. Girdlestone, Birkenhead—Projectiles.
1455. H. Deacon, Appleton—Manufacture and production of certain colours, and the apparatus employed therein.
1456. A. Smith, Mauchline—Balances for weighing letters and other documents.
1457. E. Whittaker and J. Clarke, Hurst—Machinery for preparing cotton or other fibrous materials to be spun.
1458. H. Delvigne, Paris—Fire-arms.
1459. J. Smith, sen., Coven, Wolverhampton—Thrashing machines.
1460. J. Brant, City-road Basin—Construction of armour plated ships, and cements or compositions for uniting iron to iron, and for uniting other substances, which compositions may also be used for caulking and for coating ships' bottoms.
1461. A. Nicole, 14, Soho-square—Stop watches and time keepers, and instruments for measuring accurately short intervals of time.

Dated May 15, 1862.

1462. J. Fletcher and J. Fuller, Salford—Machinery for rolling, bending, and planing metals.
1463. T. Le Mesurier, Guernsey—Raising sunken vessels and other heavy bodies.
1464. G. Sanborn, 100, Fleet-street—Machinery for spinning.
1465. R. Walsham and J. Walsham, Birmingham—Improved sleeve tie or fastener.
1466. J. Jouvin, Rochefort-sur-Mer—Preserving iron-plated and other vessels and metallic articles from oxidation, and preventing ships' bottoms from fouling.
1467. J. Dicker, Hendon—Apparatus for the delivery of bags or parcels from railway trains in motion.
1468. W. Sissons, Kingston-upon-Hull—Machinery for driving piles by means of steam hammers.
1469. G. Birkbeck, 34, Southampton Buildings—Apparatus for consuming smoke.
1470. J. Stone, Deptford—Downton's ship bilge pumps and fire engines.
1471. J. Wright, 42, Bridge-street, Blackfriars—Rotative travelling crane.
1472. J. Wright, 42, Bridge-street, Blackfriars—Machinery for digging, excavating, and removing earth, gravel, and such like substances.
1473. C. Attwood, Durham—Manufacture of steel and iron of a steely quality.
1474. C. Tress, Blackfriars-road—Hats, helmets, bonnets, or caps.
1475. I. Baggs, Cambridge-terrace, and W. Simpson, Maidstone—Treating straw, Spanish grass, and other vegetable fibres in preparing a bleaching agent for vegetable fibres, and recovering and treating an alkali resulting from the treatment of the said fibres, and apparatuses employed therein.
1476. C. Girardet, Vienna—Buckles.
1477. A. Watney, 55, Upper Berkeley-street, Portman-square—Constructing ships, vessels, and other structures intended to resist shot.

Dated May 16, 1862.

1478. P. Parsons, Blackheath—Ordnance and other fire-arms, and tools for rifling the same.
1479. J. and T. Railton, Blackburn—Warping machines.
1480. G. Haseltine, 100, Fleet-street—Churns.
1481. R. Fenner, 7, Red Lion-court, Fleet-street—Machinery for folding envelopes.
1482. R. Laming, Hampstead—Electric telegraphs.
1483. C. Binks, Parliament-street, Westminster—Treating linseed and other oils and fats.
1484. A. Lamiable, 4, South-street, Finsbury—Cementing cast and wrought iron to obtain cast steel.
1485. A. Thirion, 4, South-street, Finsbury—Railway and other carriages.
1486. F. Anderson, Birmingham—Watches and other time keepers.
1487. D. Le Souef, Twickenham—Embossing metal plates.
1488. G. Davies, 1, Serle-street, Lincoln's-inn—Ribs for umbrellas and parasols, part of which is applicable to the hardening of strips of steel generally.
1489. S. Peberdy, Philadelphia, U.S.—Knitting ribbed fabrics.
1490. N. Ames, Saugus, U.S.—Self-feeding card printing press.
1491. N. Thompson, 15, Abbey-gardens, St. John's-wood—Stoppers or covers suitable for closing bottles, jars, and other similar vessels.
1492. F. Stocken, Halkin-street, Grosvenor-place — Carriages.
1493. B. Sharpe, Hanwell-park—Construction of ships and vessels, and masts and spars for the same.
1494. A. Newton, 66, Chancery-lane—Machinery applicable to the cutting of leather and other like uses.
1495. A. Newton, 66, Chancery-lane—Machinery applicable to the cutting out of boot and shoe soles, and kindred operations.

Dated May 17, 1862.

1496. C. Binks, Parliament-street, Westminster—Oxygen and chlorine gases.
1497. R. Sievier, Guildford-street, Russell-square—Naval warfare.
1498. R. Davison, London-street, and T. Johnson, Bermondsey—Machines for washing and cleansing casks.
1499. E. Tailbonis, Paris—Rectilineal knitting frames.
1500. J. Hogg, jun., Twickenham—Book-covers.
1501. J. Broadley, Saltaire, York—Apparatus employed in weaving.
1502. J. Hill, Abergavenny, and D. Caddick, Ebbw Vale, Monmouthshire—Puddling furnaces.
1503. J. Needham, Piccadilly—Sheathing or coating iron ships.
1504—C. Tessier, Paris—Safety lock.
1505. E. Bridell, Middle Temple—Manufacture of substances artificially coloured, veined, or mottled like marbles or other substances.
1506. F. Sickles, Golden Cross Hotel, Strand—Apparatus for steering vessels.
1507. J. Gore, Norfolk, U.S.—Beet shippers.

Dated May 19, 1862.

1508. J. Wright, Blackfriars—Sheathing iron or metal ships, in order to protect them from the action of salt water, fouling, and other such like influences.
1509. J. Eastwood, Blackburn—Machinery for removing and wringing hanks of thread or yarns, and all kinds of fabrics when saturated with liquid.
1510. R. Ramsden, Kingsland-road — Machinery or apparatus for mashing malt.
1511. G. Macdonald, Puttorghatta Colgany, Bengal—Ginning cotton and for cleaning and preparing any fibrous substance, and also for cleaning or polishing any metal or other substance, designated Macdonald's fibre buffs.
1512. F. Kirkman, Crouchend, Hornsey, and R. Swift, Hounslow—Improved joint for uniting or fixing posts and rails of bedsteads and other articles of furniture, posts, and rails in fencing, in the construction of framework for conservatories, emigrants, and other portable houses.
1513. W. Pickstone, Radcliffe, and T. Mellodew, Oldham—Improved fabric in the nature of a cord or corduroy.
1514. J. Lee, Leicester—Construction of traction engines.
1515. T. Weare and E. Monckton, 4, Trafalgar-square—Means and apparatus for the protection of life and property by the agency of electricity.
1516. T. Weare and E. Monckton, Trafalgar-square—Obtaining and applying light and heat by electricity.
1517. A. Newton, 66, Chancery-lane—Machinery for splitting leather.

Dated May 20, 1862.

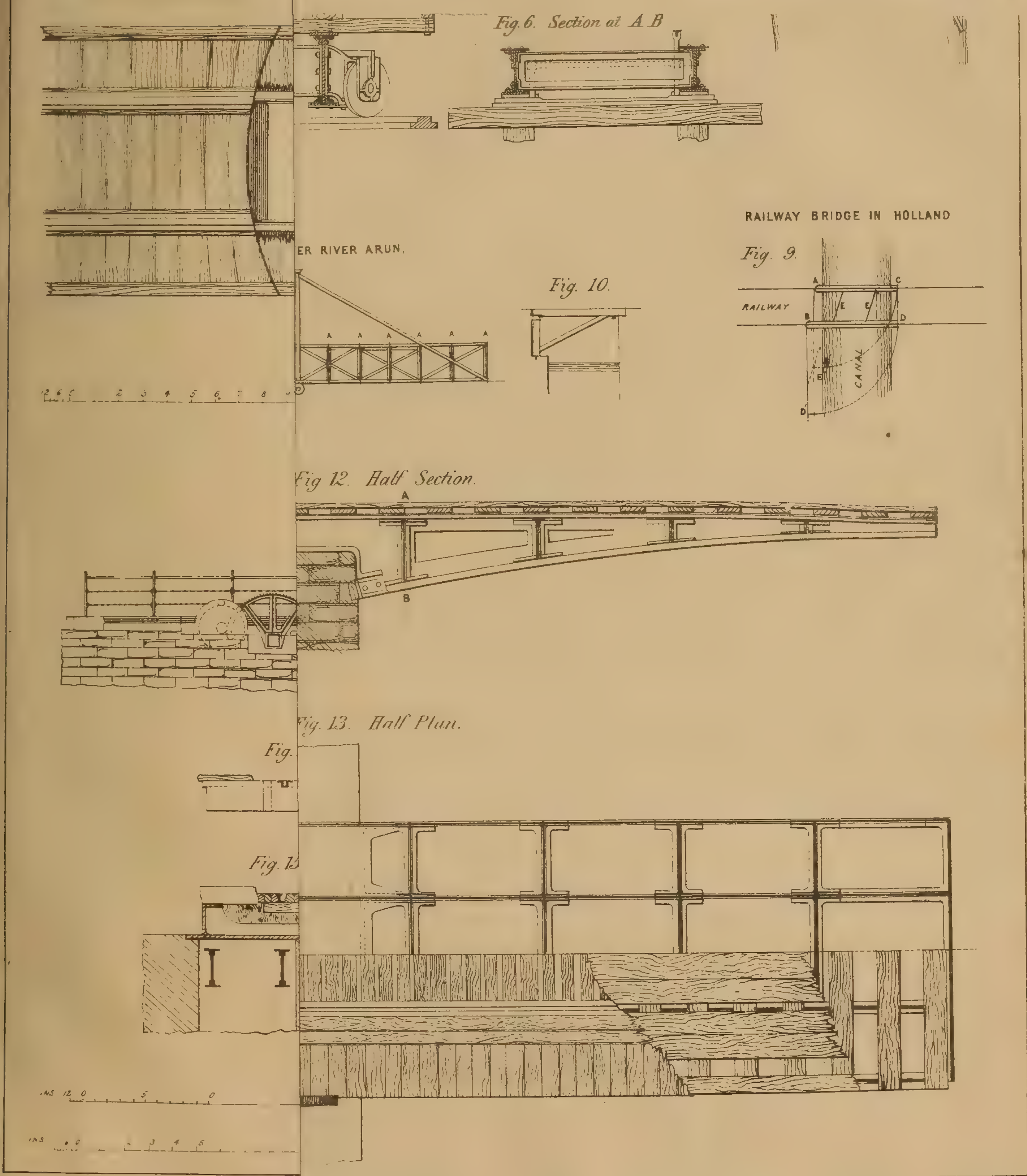
1518. M. Mennons, Paris—Breech-loading fire-arms.
1519. M. Mennons, Paris—Method of and apparatus for applying screw power to the locomotion of railway trains on steep inclines.
1520. M. Mennons, Paris—Processes for the conversion of amylaceous matters into saccharine and other useful products.
1521. W. Naylor, Dalston — Forging metals and power hammers employed therein.
1522. R. Tallerman and L. Tallerman, Bishopsgate-street Without—International ladies' companion.
1523. J. Taylor, Fenchurch-street—Abstracting heat from liquids and aeriform fluids.
1524. W. Clark, 53, Chancery-lane—Paddle and other hydraulic wheels.
1525. E. Fewtrell, Birmingham — Manufacture of metal tubes, and machinery to be employed for that purpose.
1526. M. Vogl, Sambrook-court.—Apparatus for protecting houses and other buildings from burglars.
1527. J. Kennedy, Whitehaven—Ship propellers.
1528. W. Petrie, Charlton—Vessels for boiling chemical products as sulphuric acid, and apparatus for indicating the degree of concentration and temperature of such products in the boiler, which apparatus is applicable to other pyrometric purposes.

Dated May 21, 1862.

1529. H. B. Barlow, Manchester—Presses for cotton and other substances.
1530. J. Hopkinson, 235, Regent-street—Pianofortes, and the hammer rails of pianofortes.
1531. J. Kennedy, Whitehaven—Plates for plating and for forming the outside skin of ships and vessels, and protecting the same from fouling and oxidation.
1532. W. Burnett, Margaret-street, Cavendish-square—Working telegraphic lines, and instruments and apparatus employed for telegraphic purposes.
1533. M. Le Brun Virloy, Paris—Drying and carbonizing wood, peat, and other fuel.
1534. W. Bush, Tower-hill—Construction of ships, and shields or armour for ships and batteries.
1535. A. Giles, 9, Adelphi-terrace, Strand—Constructing floating breakwaters.
1536. L. Leins, Bucklersbury—Travelling bags, and apparatus used therewith.
1537. H. Meyer, Ashford-street, Hoxton—Means of stopping or retarding railway and other carriages.
1538. W. Newton, 66, Chancery-lane—Manufacture of metallic or mineralized fabrics or surfaces.

Dated May 22, 1862.

1539. J. Oxley, Old St. Pancras-road—Making wheels, and the machinery to be employed therein.
1540. C. Siemens, 3, Great George-street, Westminster—Electric telegraph apparatus.
1541. J. Perry, 72, Piccadilly—Curing diseases of the human body by magnetism.
1542. E. De la Bastida, Bloomsbury-square—New process for the production of designs in relievo and deepening on sheets of india-rubber of any length whatever.
1543. G. Crawford, Beaumont-street, Portland-place—Musical instruments.
1544. J. Needham, Piccadilly — Breech-loading fire-arms, and cartridges for such fire-arms.
1545. S. Turnbull and F. Turnbull, Shoreditch—Floorcloths and like coverings.
1546. J. Kennedy, Whitehaven—Protecting the sides and decks of ships from the effects of projectiles.
1547. A. Childs, 481, New Oxford-street — Wringing machines.
1548. P. Hodge, Tokenhouse-yard—Dinner, supper, breakfast, or dessert plate.
1549. G. Barlow, Birmingham — Submarine telegraphic cables.
1550. H. Cook, Manchester—Electric batteries.
1551. W. Roberts and T. Greenacre, Millwall—Cocks or valves for steam or other fluids.
1552. W. Evans, Commercial-road East—Obtaining motive power by machinery.
1553. G. Goransson, Gefle, Sweden—Manufacture of armours of malleable iron or other suitable metal, and to fasten them to vessels, batteries, and other structures.



W. Smith, C.E. direx.

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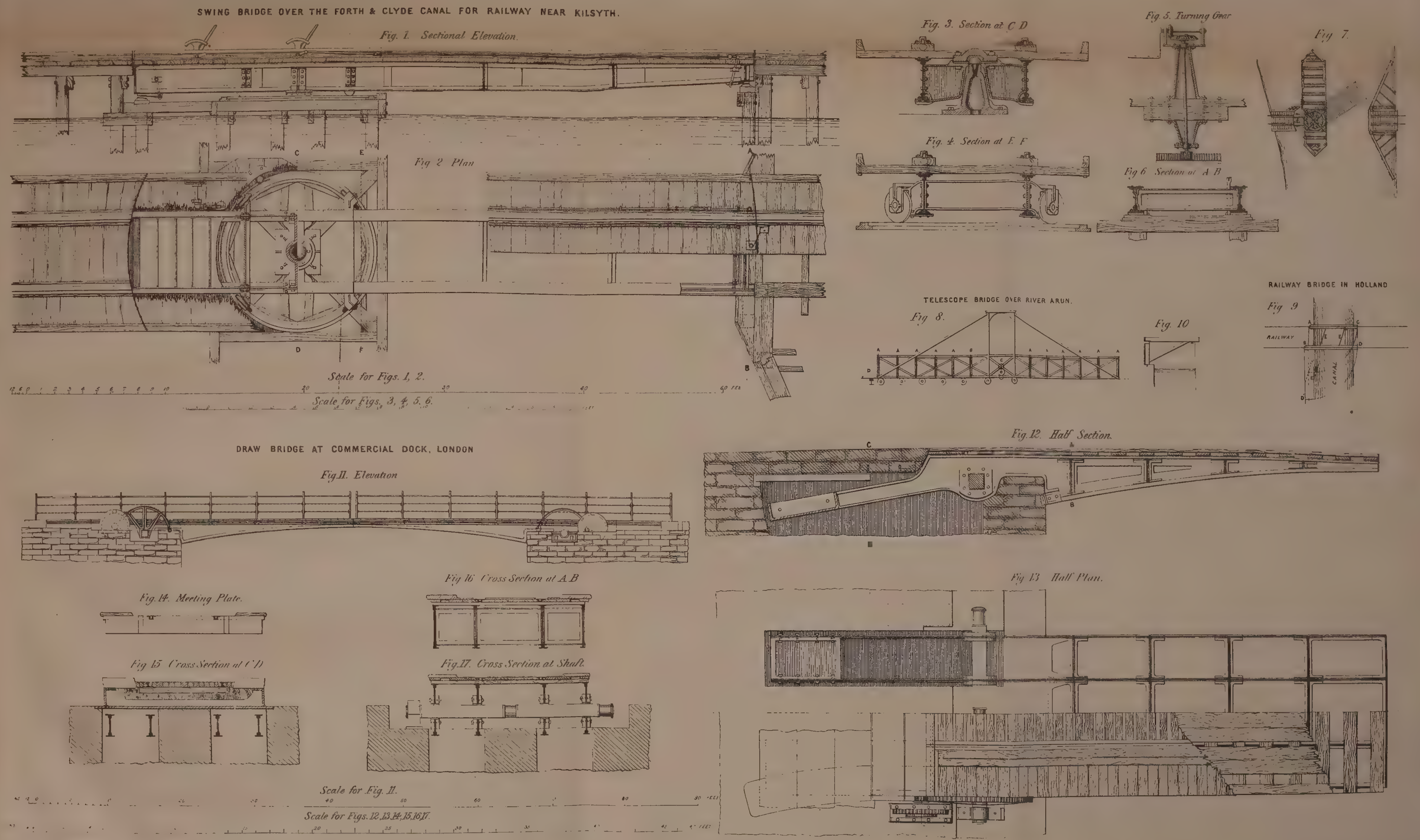
MOVABLE BRIDGES.



W. Smith C.E. direx

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THE ARTIZAN.

No. 235.—Vol. 20.—JULY 1, 1862.

MOVABLE BRIDGES.

A paper upon several types of movable bridges was read at the last meeting of the Institution of Engineers in Scotland. The subject is one we consider as deserving of notice, we have therefore given the paper *in extenso* at p. 156, and have illustrated in plate 218 some of the examples of bridges therein referred to. We do not, however, find any mention therein of what we conceive to be the most approved forms of movable bridges—viz., *Balance Rolling Bridges*.

Messrs. Turner and Gibson, of the Hammersmith Works, Dublin, have invented balance rolling bridges, of a very simple and convenient construction, which are easily worked, and especially adapted for crossing dock entrances, canals, &c. The bridges have also been erected, and found to answer admirably for ordinary traffic and for railroads. As we intend shortly to give a plate and description of these, we do not purpose to enter upon the subject at present; but to those who take interest in the subject, we may state that models may be seen in the International Exhibition, Class 10, No. 2552.

USEFUL NOTES AND FORMULÆ FOR ENGINEERS.

(*Continued from page* 79.)

Strain on Arches and Suspension Chains.

The arch and suspension chain are identical in principle, the only difference between them being that the arch is subjected to compression, and the suspension chain to tension.

The suspension chain being flexible can be altered in its form by any partial load, which the arch cannot. If we suppose a chain supported at its ends by two points infinitely close together, then the chain is subject to the least tensile strain, having only its own weight to carry; if these points be gradually removed from each other, the tensile strain will continually increase until the chain is straight when it will assume the condition of a straight girder, and be subject to both tension and compression. If it now begins to curve upwards the strain will become wholly compressive, and the structure will be an arch. As the points of support are brought closer together the strain continues to decrease until the points of support become one, when the strain is at a minimum, and the conditions of a column are assumed.

Arches are constructed of various forms, although a parabolic curve seems to be most suitable.

The form which an uniform chain or cord assumes when freely suspended from two points is termed the catenary curve, and this is always assumed when the chain has only its own weight to carry; but if the chain were devoid of weight and an uniformly distributed load were suspended from it the form of the chain would be that of the parabola. In practice the form of the chain is influenced both by its own weight and by the load; it is therefore some curve intermediate between the catenary and parabola, approaching one or the other, as the chain or load becomes heavier, but it usually approaches nearer to the parabola than to the catenary. The true form of the curve has been demonstrated by Professor Moseley, but it is sufficient for all practical purposes to consider it as a parabola.

Before proceeding to the determination of the strains upon arches and suspension chains, we will give a formula for finding the length of the suspension rods and of the chain, on the supposition of its forming a parabola.

Let l = length of any suspension rod
l_1 = length of shortest suspension rod.
d = deflection of chain.
s = semispan.
x = distance of suspension rod from centre of chord.
L = length of half the chain.

Then

$$l = l_1 \times \frac{d\,x^2}{s^2}$$

$$L = \sqrt{s^2 + \frac{4}{3}d^2}$$

Theory of the Arch.

Let A B (Fig. 24) represent half an arch subject to an uniformly distributed load.

Let P = horizontal pressure produced by the other part of the arch.
W = total load on the arch.
W_1 = load between the centre of the arch and any section.
S = the span.
V = versine to the line of resistance.

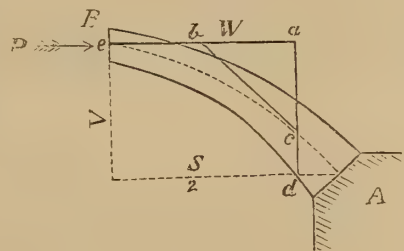


Fig. 24.

From the point e at the centre of gravity of the section draw the horizontal line $a\,e$, which is the direction of the horizontal pressure P. From a let fall the perpendicular ad; then the forces acting on a section c will be represented by the sides of the triangle $a\,b\,c$, $a\,b$ being equal to P, the horizontal pressure, and $a\,c$ equal to W, the vertical load; $b\,c$ will be the resultant of these two forces.

We first find the form assumed by the line of resistance; c the intersection of $c\,b$ with $a\,d$, being one point in the line and e another.

Let R = the thrust at the point c.

$\alpha = \angle\, a\,b\,c$ = inclination of curve of resistance at c.

then,

$$W_1 = P \tan. \alpha.$$
$$R = \sqrt{(P^2 + W_1^2)} = P \sec. \alpha.$$

To obtain from these an equation to the curve, let that curve be referred to rectangular co-ordinates, horizontal and vertical, commencing at e, the highest part, and call $a\,e = x$, $a\,c = y$; then,

$$\tan. \alpha = \frac{d\,y}{d\,x}$$

$$\therefore \frac{d\,y}{d\,x} = \frac{W_1}{P} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

From this equation, the equation to the curve may be obtained when the distribution of the load is known.

Let w = load per foot lineal.

$$\therefore W_1 = w\,x,$$

and the equation (1) becomes

$$\frac{d\,y}{d\,x} = \frac{w\,x}{P}$$

This being integrated, remembering that when $x\,o = y = o$

$$y = \frac{w\,x^2}{2\,P}$$

which is an equation to the parabola.

Hence it appears that the curve of resistance is a parabola.

Let β = the angle made with the horizon by a tangent, the curve at its point of intersection with the abutment.

Then for the thrust at the centre of the arch we have,

$$P = \frac{W}{\tan \beta} = \frac{W\,S}{8\,V}$$

for the thrust at any section c

$$R = \sqrt{\frac{W^2\,S^2}{64\,V^2} + W_1^2}$$

for the thrust at the abutment,

Let T = the thrust.

$$T = W\sqrt{\frac{S^2}{64\,V^2} + \frac{1}{4}}$$

Arch for Uniform Fluid Pressure.

It is evident that an arch to resist an uniform fluid pressure from without should be circular, because as the force to which it is subjected is similar all round, its figure should be similar all round.

To find the thrust on the ring or circular arch,

Let p = pressure per square foot on the circumference.
r = radius of ring.
T = thrust on a part of the ring one foot in width.

then,

$$T = p\,r$$

The hydrostatic arch is a linear arch, suited for sustaining normal pressure at each point proportional to the depth below a given horizontal line, such as that produced by a liquid in repose.

To have the thrust on the arch uniform, the radius of curvature at any point should be inversely as the pressure at that point. The thrust on the arch is equal to the pressure multiplied by the radius of curvature. The hydrostatic arch is found to present some resemblance to a trochoid, but it is not identical with that curve.

Pointed Arches.

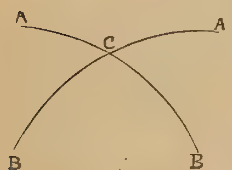


FIG. 25.

If a linear arch, as in Fig. 25, consists of twoarcs B C, C B, meeting in a point at C, it is necessary to equilibrium that there should be concentrated at C, a load equal to that which would have been distributed over the two arcs A C, C A, extending from the point C to the respective crowns A A of the curves, of which two portions form the pointed arch.

THEORY OF SUSPENSION CHAINS.

The form of the curve assumed by the chain, and the formulæ relating to it have already been given.

The strains on a suspension chain may be determined in a manner precisely similar to that applied to the arch. We shall, however, further investigate the strains upon it by another method.

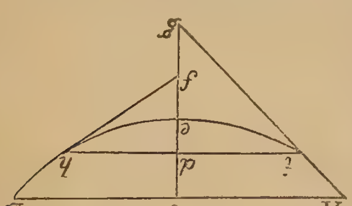


FIG. 26.

Let A B (Fig. 26) represent a suspension chain; g B is a tangent to the curve at the point of suspension, making an angle θ with the horizontal chord A c B; $h\,f$ is a tangent to the curve at any other point h, making an angle θ_1 with the horizontal semichord $h\,d$.

θ θ_1 are called angles of direction. Let it be required to draw a tangent to the curve at any point h; from h draw the horizontal chord $h\,i$; and from the centre of this chord line let fall the perpendicular $d\,f$; make $d\,f$ twice the deflection $d\,e$, and join $h\,f$; then $h\,f$ will be the tangent, and $f\,h\,d$ will be the angle of direction. As sin. θ and tan. θ will be required, we will give formulæ for finding them before proceeding further.

Let d = the greatest deflection.
s = the semichord.

then,

$$\text{Tan}\ \theta = \frac{2\,d}{s}$$

$$\text{Sin.}\ \theta = \frac{2\,d}{\sqrt{(2\,d)^2 + s^2}}$$

To find the tension on the chain,

Let W = half the total load.
T = tension at point of support.
t = lowest point in chain.
θ = the angle of direction at point of support.

Then

$$T = \frac{W}{\text{sin.}\ \theta},\ \text{and}$$

$$t = \frac{W}{\text{tan.}\ \theta}.$$

Let L = span of chains.

Then substituting the values of the tangent and sine,

$$T = \frac{W\sqrt{s^2 + 4\,d^2}}{2\,d}$$

$$t = \frac{W\,L}{4\,d}$$

ON THE RELATION BETWEEN THE DENSITIES AND VOLUMES OF VAPOURS AND OF GASES.

BY JOSEPH GILL.

In an essay on the Thermodynamics of Elastic Fluids, I had lately occasion to point out that serious errors would result from supposing the thermic phenomena of vapours and of gases to be governed by the same laws. I have now some additional observations to make in elucidation of the above remark, which I think will be found of much importance, as tending to draw attention to what appear to me some very serious mistakes in the novel doctrine of thermodynamics, as at present generally taught; and as affecting metereological knowledge, both in a purely scientific point of view, and as bearing on many questions of industrial and sanatory interest, and domestic comfort, influenced by the constitution and varying states of the atmosphere.

The vapour of water at 212° has the tension of one atmosphere = 14·7lbs. per square inch. If allowed to expand into double its volume, the temperature naturally falls to 180°, and the pressure becomes half an atmosphere. Expanded to four times its volume, the temperature falls to 150°, and the pressure becomes quarter of an atmosphere; and so on, the pressure or tension diminishing directly as the volume increases, and the temperature falling in a ratio which has been represented by formulæ deduced from experiment, no exact law of the correspondence between temperature and pressure being known.

It should be borne in mind that the total heat in aqueous vapour is supposed to be nearly a constant quantity, and consequently the fall of temperature which always accompanies expansion is not supposed to indicate any loss of heat in the expanded fluid. Dr. Lardner was one of the first to point out the error of supposing that steam could be partially condensed by compression only, without loss of heat. In his treatise on heat (Cab. Cyclop), chap. vii., he states:—"Steam has that quantity of latent and sensible heat which is necessary and sufficient to maintain it in the vaporous form in all degrees of density." This is a necessary deduction from the broad fact generally admitted, that the heat of steam is a constant quantity, or nearly so. It is surprising, however, that with the clear views of the constitution of steam which enabled him to detect the above error, he should have fallen into a mistake, perhaps equally grave, by asserting (*Treatise on Heat*, pp. 164-5):—"It has been stated by philosophical authorities that the specific gravity, or density of steam is always proportional to its pressure. This, however, is not correct. The true law for the variation of the density or specific gravity of steam is the same as that of air: it is proportional to the pressure or elasticity, provided the temperatures are the same. If, then, we have steam raised from water under two different pressures, and at two different temperatures, let the temperatures be equalised by applying heat to the steam of the lesser pressure, out of contact with water, its pressure being meanwhile preserved. When the temperatures are thus rendered equal, then their densities or specific gravities will be in the same proportion as their pressures."

The fallacy of the foregoing statement is so obvious that we need not lose time in proving it. There can be no doubt that the specific gravity or density of steam is always proportional to its pressure; consequently, in comparing the densities of saturated vapours of different elastic pressures, the temperatures are to be taken as they will be naturally found in each case, that is, as corresponding respectively to the pressures. It is to be regretted that in works of more recent date, and having high pretensions to philosophical accuracy, the same fallacy should be found under various forms, influencing the results of calculation and formula to the extent sometimes of a divergence of nearly 30 per cent. from the physical facts, as in the case of the proportion of water existing as vapour in the atmosphere under ordinary circumstances.

The density or specific gravity of steam at 212°, and of common atmosheric pressure is about $\frac{5}{8}$ of that of air at 212° under the same pressure; or as 0·610 to 1·000. Hence it is generally stated in elementary works on physics that the specific gravity of saturated vapour, at any temperature, may be found by multiplying by 0·610 the specific gravity of dry air at the same temperature and the same elastic pressure. A little consideration will show the error of this method. Suppose a cubic foot of atmospheric pressure steam to be expanded into double its volume, the pressure will evidently fall to that of half an atmosphere, and experiment shows that the corresponding temperature is 180°. Let a cubic foot of air of atmospheric pressure, and 212° temperature, be expanded into double its volume, and it will be found that the pressure is not half an atmosphere, unless the initial temperature of 212° be maintained. Supposing the temperature to be made equal to that of the expanded steam, or 180°, it will be less than the original temperature by an interval of 32 degrees, and the pressure will be less by an amount corresponding to this difference of temperature at the rate of $\frac{1}{493.2}$ for each degree which is the amount of expansion under constant pressure, or of increased tension under constant volume, resulting from the action of heat in a perfect gas. Thus the pressure of the expanded steam at its natural temperature of 180°, the only temperature at which it can exist as steam or saturated vapour at this pressure, would be $14{\cdot}7 \div 2 = 7{\cdot}35$lbs. per sq. in., while the pressure of the expanded air at the equal, but arbitrary temperature of 180° would be only 6·87lbs. per square inch—a differense of nearly $\frac{1}{15}$th. Consequently so much more dry air must exist in the given space of 2 cubic feet at 180° to produce the pressure of half an atmoshere, or about 1·066 cubic foot taken at the initial temperature of 212°, and of atmospheric pressure. It is evident, therefore, that the proportion between the densities of saturated vapour and of dry air at equal pressures, varies with the circumstances. We have seen that in applying the above-mentioned rule for finding the density of vapour saturating a given space, at 180°, the result would show an error of about $\frac{1}{15}$th in excess; and the divergence increases as temperature lowers, till at 32° there results an error of about 30 per cent., as mentioned above.

The pressures exerted by vapours at low temperatures are easily found by experiment, but it is very difficult to ascertain their weight experimentally; and therefore the densities of vapours of low tension are generally deduced from calculation, sometimes from their chemical composition, taking the constituent ingredients in the state of perfect gases. An example of this latter method is given in Professor Rankine's *Manual of the Steam Engine and other Prime Movers*, p. 230, in which the ideal weight of a cubic foot of steam at 32°, and under one atmosphere ("being a quantity to be used in calculation only, inasmuch as steam cannot exist at that pressure and temperature)," is computed as follows:—One cubic foot of hydrogen, weighing 0·005592lb. at 32°, and half a cubic foot of oxygen, weighing 0·044628lb. at the same temperature, combine together, and collapse into one cubic foot of steam. Hence the sum of these two weights, or $0{\cdot}005592 + 0{\cdot}044628 = 0{\cdot}050220$lb., is the ideal weight of one cubic foot of steam at 32°.

The volume of 1lb. of water supposed to exist as vapour under these conditions would be 19·913 cubic feet. With each degree of increased temperature its volume, under constant pressure, if obeying the law of perfect gases, would expand

$$\frac{1}{493{\cdot}2}$$

or in decimals, 0·0020276; so that at the temperature of 212°, or 180° above 32°, its volume (under constant pressure) would be increased by $180 \times 0{\cdot}0020276 = 0{\cdot}365$ of the initial bulk at 32°, and the vapour at 212° would occupy a space of 27·18 cubic feet, thus reducing the weight of 1 cubic foot from 0·05022 lbs. at the ideal temperature of 32°, to 0·03679 lbs. at the real temperature of 212°, which nearly coincides with the results of experiment, 0·03799lbs. being the weight of 1 cubic foot of saturated aqueous vapour at 212°, the pressure being 14·7lb. per square inch, or 1 atmosphere.

If the gases be taken at the temperature of 212°, and atmospheric pressure, their weights would be—

1 cubic foot of hydrogen	0·00409 lbs.
½ „ oxygen	0·03270 lbs.
	0·03679 lbs.

thus giving directly the weight of 1 cubic foot of steam at 212°, and atmospheric pressure, as deduced from its chemical composition.

It is admitted as a well established law that perfect gases combine by volumes in numerical ratios only.

It is also admitted that the volume of a given weight of a compound perfect gas always bears simple numerical ratios to the volumes which its constituents would occupy separately.

The application of these laws to the case of steam was shown above, and with saturated aqueous vapour at atmospheric pressure, the difference between the results of calculation and of experiment is only about one-fiftieth. In the case of the vapour of ether, also, the results of the two modes of computation have been found to agree well under pressures not differing much from ordinary atmospheric pressure. But, from the knowledge that vapours and gases do not follow the same laws in changes of volume and of density, we are led to enquire whether the method of computing the density of gases from their chemical composition as generally practised, is proportionately correct under different circumstances alike. In the case of steam we admit that two volumes of hydrogen and one volume of oxygen, both at 212°, and atmospheric pressure combine to form two volumes of steam at 212°, and of atmospheric pressure, the weight of the steam being, of course, the sum of the weights of the gases composing it. The pressure of steam at 212° is 2116·4 lbs. per square foot. At 32° the pressure of saturated aqueous vapour is found to be 12·27 lbs. per square foot. Now keeping in mind what has been already said, that "steam has that quantity of latent and sensible heat which is necessary and sufficient to maintain it in the vapourous form in all degrees of density," and hence deducing the correctness of the assumption generally admitted that the densities of saturated vapours are as the pressures, we should have—

$$\frac{2116{\cdot}4}{12{\cdot}27} = 172$$

as the number of volumes into which steam of atmospheric pressure would expand in lowering its temperature to 32°, and its pressure to 12·27 lbs. per square foot. That is to say, 1 cubic foot of steam at 212° would, in the act of moderated expansion into 172ft., assume this temperature and this pressure.

Let us now inquire how the gases constituting this steam would comport themselves in undergoing an equal amount of expansion. The 1½ cubic foot of mixed gas at 212° in expanding under moderate pressure to the same amount as the steam expanded, viz., into 172 volumes, would suffer a reduction of temperature far below 32°; but imagining the temperature to be maintained at 32°, so as to be equal to that of the expanded steam, it will be found that the pressure will be still much lower than that of the steam, because the peculiar constitution of gases requires that a dry gas in enlarging its volume should have its full initial temperature maintained, in order that its pressure may be as the volume, according to Marriott's law. In the case we are considering there is a difference of temperature of $212° - 32° = 180°$, which obviously must cause a corresponding difference in the pressure, amounting to more than one-third, or $180° \times 0{\cdot}002076$ (the co-efficient of expansion) $= 0{\cdot}365$ of the original pressure. Therefore taking (from a larger quantity) the given volume of—

$$172 + \frac{172}{2} = 258 \text{ feet}$$

of the mixed gas at 32°, and the pressure of 12·27 lb. per square foot, we should have an increase of weight proportional to the above difference of temperature, as 352ft. of the mixed gas at 312° would shrink into the space of the 258 feet at 32°, and consequently the weight of the resulting vapour being equal to the weight of its components, while its volume at 32° would be still 172 times the volume at 212°, the resulting vapour would be 235ft. instead of 172ft.

It appears evident, therefore, that the proportions between the volumes and weights of vapours and gases vary greatly with the circumstances, so that 1 cubic foot of hydrogen, and ½ cubic foot of oxygen taken at the temperature of 32°, and the pressure of 12·27 lbs. per square foot, would produce more than $1\frac{1}{3}$ foot of saturated vapour at the same temperature and pressure, instead of 1 cubic foot as generally calculated on the erroneous supposition that the thermic phenomena of vapours and gases are governed by the same laws. Hence the errors above alluded to as pervading our best elementary treatises.

In Professor Rankine's *Manual of the Steam Engine and other Prime Movers*, we find the following correct data:—

The pressure of the vapour of water at 50° = 24·92 lbs. per sq. ft.
„ „ 212° = 2116·40 lbs. „

And 0·03797 lbs. of saturated aqueous vapour fills 1 cubic foot of space at 212°, the pressure being 14·7 lbs. per square inch, or one atmosphere.

Hence, as the densities of saturated vapours are as the pressures, the weight of 1 cubic foot of vapour at 50° is found as follows:—

2116·4 lbs. press. : 24·92 lbs. press. :: 0·03797lbs. weight : 0·000447lbs. weight. or 0·000447lbs. of water would saturate the space of 1 cubic foot with vapour of the pressures of 24·92 lbs. per square foot, or 0·173 lbs. per square inch, at the temperature of 50°. But our highest authorities give 0·000577 lbs. as the quantity required. Professor Rankine (*Manual of Steam Engine, &c.*, p. 240) states: "It is necessary to molecular equilibrium that the space of one cubic foot above water at 50° should contain 0·00058 lbs. of watery vapour, whether and to what amount soever air, or other gaseous substance not chemically attracting the water, is contained in the same space." The discrepancy between the two weights 0·000477 lbs. and 0·00058 lbs., upwards of 28 per cent., arises from the supposition that the thermic phenomena of vapours follow the same laws as those of gases. In the working of heat engines where the motive fluids are used at comparatively high temperatures and pressures, the differences between theory and practice are comparatively small; but when in meteorological reasonings we see an amount of water supposed to exist as vapour in the atmosphere of nearly 30 per cent., at ordinary temperatures, more than the probable actual quantity, we cannot fail to perceive the importance of a careful investigation of the subject, so as either to confirm the views of our leading philosophical authorities if correct, or to modify them if found to be erroneous.

This paper has been written with the hope of attracting to this important subject the attention of intelligent practical men, who might investigate the question in a plain matter of fact way, and divested of the mathemetical garb, which, I am sorry to say, still has to many, the effect of obscuring physical facts, instead of rendering the phenomena more obvious to the mental vision. While, therefore, our mechanical artizans, whose practical dexterity and technical knowledge, are universally acknowledged, ought carefully to cultivate the mathematical training which is essential to intellectual superiority; their attention may at the same time be profitably drawn to the consideration of the principles of the grand automata, which now form the most interesting object of their professional labours, by putting before them some important thermodynamical problems, in a form which may bring them within the reach of any earnest inquirer of common intelligence. We are too much in the habit of trusting implicitly to scientific authority in such matters, and the result of such habits is, that a large majority of our mechanical engineers are content to work out their problems by rule, being perhaps possessed of sufficient dexterity in the use of formulæ, without at the same time perceiving clearly the physical conditions represented by the symbols, and thus running the risk of committing serious errors under the appearance of mathematical sanction. At all events it must be allowed that true philosophical improvement in our heat engines ought to be expected, principally from men who should professionally combine sound theory with efficient practice, and it should be the the duty of our public teachers in this important branch of physical science, to give plain practical versions of such scientific novelties as they may discover. "To present their results in that simple form in which alone great truths present themselves to those who thoroughly understand them." Such a practice would be highly beneficial to numerous readers, possessing a knowledge of physical reasoning, though wanting the mathematical learning, requisite to treat such subjects on the higher scientific plane to which their theoretical development more properly belongs. Dr. Lardner says:—"The phenomena of heat all admits of being explained without the aid of abstruse reasoning; technical language, or mathematical symbols. The subject abounds in examples of the most felicitous processes of induction from which the general reader may obtain a view of that beautiful logic, the light of which Bacon first let in on the obscurity in which he found physics involved."

My assumption that the volume of saturated vapour is always as the pressure, which forms the basis of the foregoing paper, is drawn from the results of a very long series of experiments connected with the practical working of heat engines, but not direct enough in form to be, in themselves, sufficiently convincing without analogical reasoning which it is not my intention to present now; and on this point I would merely remark that the heat of conversion of vapours cannot probably perform two distinct functions at once, being entirely employed in the state of the liquid (and consequently augmenting its volume), it should not be expected at the same time to affect directly its bulk, as it were, a second time in the form of vapour. It has occurred to me, however, that I should quote the direct experiments of Mr. Fairbairn and Mr. Tate, in 1859, in support of my views. The results were given, as approximations only, as follows, in the first three columns, the fourth would be the result of the law of the densities being as the pressures, calculated from the common tables of temperatures and pressures o steam.

Temperature.	Volumes of Steam.		
	By common formula.	By Fairbairn's experiments.	As density to pressure.
244°	1005	896	927
257°	790	751	747
262°	740	680	676
268°	680	633	634
270°	660	604	603
283°	540	490	492

It will be seen from the above numbers that Fairbairn's experiments gave quantities nearly approaching those which would result from the densities being as the pressures, which, I have no doubt, is the true physical law. I am not aware that Mr. Fairbairn has published more recent results of his, and Mr. Tate's experiments. A fuller investigation of the subject by such able hands, would be a great boon to scientific men.

STRENGTH OF MATERIALS.

DEDUCED FROM THE LATEST EXPERIMENTS OF BARLOW, BUCHANAN, FAIRBAIRN, HODGKINSON, STEPHENSON, MAJOR WADE, U.S. ORDNANCE CORPS, AND OTHERS.

(Continued from page 132).

Torsional Strength.

The torsional strength of any square bar or beam is as the cube of its side, and of any cylinder as the cube of its diameter. Hollow cylinders or shafts have greater torsional strength than solid ones containing the same volume of material.

The torsional angle of a bar, &c., under equal pressures, will vary as the length of the bar, &c. Hence, the torsional strength of bars of like diameters are inversely as their lengths.

The strength of a cylindrical prism compared to a square is as 1 to ·85.

When a bar, beam, &c., having a length greater than its diameter, is subjected to a torsional strain, the direction of the greatest strain is in the line of the diagonal of a square, and if a square be drawn on the surface of the bar, &c., in its primitive form, it will become a rhombus by the action of the strain.

Tables of the Torsional Strength of Materials.

Deduced from the Experiments of Major Wade. U.S.A., and Reduced to a Uniform Measure of

One Inch Square or in Diameter, Weight or Stress applied at one foot in Length from Centre of Axis of the Material, and at the face of the Axis or Journal.

Section of Figure.	Side (S).	External diameter.	Internal diameter.	Length of journal, or part acted on.	Area of section.	Breaking weight of figure.	Breaking weight per inch diameter or side.
	Inch.	Inch.	Inch.	Inch.	Sq. inch.	lbs.	$W \div S^3$
Square	1·	1·	....	3·	1·	730	730
”	1·415	1·415	....	3·55	2·	1916	677
”	1·750	1·750	....	4·80	3·	4500	839
Cylinder	1·135	....	....	3·	1·	896	613
”	1·595	....	....	3·60	2·	2790	687
”	1·955	....	....	4·80	3·	4750	636
							$W \div (S^3 - S'^3)$
Hollow cylinder	....	1·300	·650	3·35	·995	1083	564
” ”	....	1·811	·906	3·60	1·012	3104	597
” ”	....	2·261	1·280	4·60	1·931	5104	540
” ”	....	1·415	·839	5·60	1·967	1302	580
” ”	....	2·211	1·544	5·75	2·728	4125	579
” ”	....	3·250	2·605	8·00	2·926	7916	475

Summary of Preceding Results.

Area of cross section.	Breaking weight of figures.					
	Square $b\ d^2$.	Cylinder d^3.	Area of section.	Hollow cylinder $d^3 - d'^3$.	Area of section.	Hollow cylinder $d^3 - d'^3$.
Inch.	lbs.	lbs.	Inch.	lbs.	Inch.	lbs.
1	730	613	·995	563	1·012	585
2	677	698	1·931	597	1·967	579
3	430	636	2·728	540	2·966	476
Mean...	749	649		567		547

All of the bars were from the same mixture of common foundry iron, of a mean torsional strength of 644 lbs. per square inch of section. From these results it appears that solid square shafts have about one-fifth less strength than solid cylinders of equal areas.

The stress which will give a bar a permanent set of $\frac{1}{2}$°, is about seven tenths of that which will break it, and this proportion is quite uniform, even when the strength of the material may vary essentially.

The strongest bars give the longest fractures.

Wrought iron, compared with cast iron, has equal strength under a stress which does not produce a permanent set, but this set commences under a less force in wrought iron than cast, and progresses more rapidly thereafter. The strongest bar of wrought iron acquired a permanent set under a less strain than a cast iron bar of the lowest grade. The mean *values* of cast and wrought iron and bronze, for bars of small diameters for a permanent set of $\frac{1}{2}$°, are as 1·, ·6, and ·33.

TABLE *of the Torsional Strength of Cast and Wrought Iron and Bronze, with their values for different Diameters.*

Length of Journal, or of the Bar or Beam submitted to Strain, for which the values are given, three times the Diameter or Side of the Shaft.

FIGURE.	Specific gravity.	Length of journal or side.	Breaking weight.	Value for diameter of 2 ins.	5 ins.	10 ins.	15 ins.
		Inch.	lbs.				
CYLINDER.—CAST IRON.							
Good common castings	7·180	8·	583	170	115	105	100
„ „ cold blast, mean of 8 trials	......	8·	705	175	120	110	105
Gun iron, small bars	7·320	8·	750	190	130	120	115
greatest extreme	7·724	8·	833	200	135	125	120
CYLINDER.—WROUGHT IRON.							
Begins to yield, permanent set	7·855	8·	300 }	130	128	125	123
Bends without breaking	......	8·	642 }				
CYLINDER.—BRONZE.							
Begins to yield, permanent set	8·710	8·	192 }	55	45	35	33
Bends without breaking	......	8·	458 }				
SQUARE.—CAST IRON	7·200	3·	730 }	220	150	140	134
„ „	......	4·8	840 }				
„ WROUGHT IRON	7·855	3·	......	170	165	160	162
HOLLOW CYLINDER. „ „							
Diameters, 1·3 and ·65	......	3·35	1083	163	110	100	96
„ 2·26 „ 1·28	......	4·60	5104	153	105	96	92
„ 3·25 „ 2·60	......	8·	7916	135	90	83	80

The experiments above given were made with bars not exceeding 2 inches in diameter; the relations given, therefore, do not hold, as the diameters are increased, in consequence of the shrinking of the cast metals in cooling, which by cooling at the outer surface first, draws the metal from the centre and in effect gives to a bar or shaft the properties of a hollow cylinder. In shafts of 10 inches in diameter, the torsional strength of wrought iron is considered fully equal to that of cast iron, and with larger diameters it would be much greater but that it suffers deterioration as its diameter increases, from the increased difficulty in effecting welding and the reduction of the metal to a fibrous texture.

The following rules, in all instances, are purposed to apply to the diameters of the journals of shafts, or to the diameter or side of the bearings of the beams, &c., where the length of the journal or the distance upon which the strain bears, does not greatly exceed the diameter of the journal or side of beam, &c., hence, when the length or distance is greatly increased, the diameter or side must be correspondingly increased.

To ascertain the Torsional Strength of Square or Round Shafts, &c.

RULE.—Multiply the value in the preceding tables by the cube of the side or of the diameter of the shaft, &c., and divide the product by the distance from the axis at which the stress is applied in feet; the quotient will give the resistance in pounds.

EXAMPLE.—What torsional stress may be borne by a cast iron shaft o the best material, 2 inches in diameter, the power being applied at 2 feet from its axis?

$$125 \times 2^3 = 1000 \text{ and } \frac{1000}{2} = 500 \text{ lbs.}$$

To ascertain the Diameter of a Square or Round Shaft, &c., to resist Torsion.

RULE.—Multiply the extreme of pressure on the crank pin, or at the pitch line of the pinion, or at the centre of effect on the blades of the wheel, &c., that the shaft may at any time be subjected to, by the length of the crank or radius of the wheel in feet, &c.; divide their product by the value in the preceding tables, and the cube root of the quotient will give the diameter of the shaft or its journal in inches.

EXAMPLE.—What should be the diameter for the journal of a wrought iron water-wheel shaft, the extreme pressure on the crank pin being 59,400 lbs. and the crank 5 feet in length?

$$\frac{59400 \times 5}{125} = 2376 \text{ and}$$

$$\sqrt[3]{2376} = 13{\cdot}34 \text{ in.}$$

When two Shafts are used, as in Steam Vessets with one Engine &c.

RULE.—Divide three times the cube of the diameter for one shaft by four, and the cube root of the quotient will give the diameter of the shaft in inches.

EXAMPLE.—The area of the journal of a shaft is 113 inches, what should be the diameter, two shafts being used?

Diameter for area of 113 = 12

Then $$\frac{3 \times 12^3}{4} = 1296 \text{ and } \sqrt[3]{1296} = 10{\cdot}9 \text{ in.}$$

NOTE.—The examples here given are deduced from instances of successful practice; where the diameter has been less, fracture has almost universally taken place, the strain being increased beyond the ordinary limit.

2. When the work to be performed is of a regular character and the stress is consequently uniform, the proportion of $\frac{3}{4}$ths may be reduced to $\frac{2}{3}$ths.

Relative Values of Cast and Wrought Iron.

When shafts of less diameter than 12 inches are required the values here given may be slightly reduced, according to the quality of the iron and the diameter of the shaft to be used; but when they exceed this diameter, the values may not be increased in a like manner, as the strength of a cast or a wrought iron shaft decreases as their diameters increase.

Grier makes the difference between cast and wrought iron shafts for all diameters as ·963 to 1·000.

To ascertain the Torsional Strength of Hollow Shafts and Cylinders.

Rule.—From the fourth power of the exterior diameter subtract the fourth power of the interior diameter and multiply the remainder by the value of the material; divide this product by the product of the exterior diameter and the length or distance from the axis at which the stress is applied in feet: the quotient will give the resistance in pounds.

Example.—What torsional stress may be borne by a cast iron hollow shaft, having diameters of 3 and 2 inches, the power being applied at 1 foot from its axis?

$$3^3 - 2^4 \times 105 = 81 - 16105 = 6825,$$

which $$\div 3 \times 1 = \frac{6125}{3} = 2275 \text{ lbs.}$$

The order of journals of shafts, with reference to the degree of torsional strength to which they are subjected, is as follows:—

1. Fly-wheel shafts.
2. Water-wheel shafts.
3. Secondary shafts.
4. Tertiary shafts, &c.

Hence, the diameters of their journals may be reduced in this order.

Relative value of Different Materials to Resist Torsion. By English Authors

Materials.		Value.	Materials.		Value.
Cast Iron	1·00	112	Brass	·28	31
Wrought Iron	1·12	125	Copper	·25	28
do Swedish...	1·05	117	Tin	·15	17
Cast steel	2·17	243	Lead	·11	12
Shear steel	1·88	210	Oak	2·24	250
Blistered steel	1·84	206	White pine..............	2·05	228
Gun metal (bronze)......	·33	37			

Relative value of Different Figures to Resist Torsion, having Equal Sectional Areas.

Solid cylinder.	Solid square.	Hollow cylinders, the interior and exterior diameters of which are in the proportion of				
		4 to 10	5 to 10	6 to 10	7 to 10	8 to 10
1·000	·8750	1·2656	1·4433	1·7000	2·0864	2·7377

Detrusive Strength.

The Detrusive strength of any body is directly as its depth or thickness

Table of the results of Experiments upon the Detrusive Strength of Metals.

Materials.	diameter of shear or punch.	Thickness of metal.	Power exerted.	Power required for a surface of one square inch, viz.:— 1 inch in depth, and 1 inch in width.
	Inch.	Inch.	lbs.	lbs.
Wrought iron	·5	·08	6,025	45,000
	·5	·17	11,950	
	·5	·24	17,100	
Copper	·5	·08	3,983	30,000
	·5	·17	7,823	
Steel	·5	·25	34,720	90,000
Fir.........................	·32	1·	600	600

Comparison between Detrusive and Transverse Strengths.

Assuming the compression and abrasion of the metal in the application of a punch of one inch in diameter to extend to one-eighth of an inch beyond the diameter of the punch, the comparative resistance of wrought iron to detrusive and transverse strain, the latter estimated at 600 lbs. per square inch, for a bar one foot in length, is as 2·5 to 1.

Character of Strains to which Connecting Rods, Straps, Gibs, and Keys are subjected.

Heads of Rods.—At sides of keyholes, tensile and compressive; at back of keyholes, detrusive.

Straps,—At crown and sides of keyhole, tensile; at back of keyholes, detrusive.

Gib.—Transverse, uniformly loaded along its length, fixed at both ends.

Key.—With single gib, transverse, uniformly loaded along its length, supported at both ends.

Key.—With double gib, transverse, uniformly loaded along its length, fixed at both ends.

Woods.

When a Beam or any piece of wood is let in (not mortised) at an inclination to another piece, so that the thrust will bear in the direction of the fibres of the beam that is cut, the depth of the cut at right angles to the fibres, should not be more than one-fifth of the length of the piece, the fibres of which, by their cohesion, resist the thrust.

To ascertain the Force necessary to Punch Iron or Copper Plates.

Rule.—Multiply the product of the diameter of the punch and the thickness of the metal by 150,000, if for wrought iron, and by 96,000 if for copper, and the product will give the power required, in pounds.

(*To be continued.*)

STRENGTH OF CAST AND WROUGHT IRON PILLARS.

A Series of Tables deduced from several of Mr. Eaton Hodgkinson's Formulæ, showing the Breaking Weight anr Safe Weight of Cast Iron and Wrought Iron Uniform Cylindrical Pillars.

By Wm. Bryson, C.E.

(*Continued from page 58.*)

Hollow Cylindrical Pillars of Cast Iron, both Ends being Flat and Firmly Fixed.—Low Moor Iron, No. 2.

Length or height in feet.	Number of diams. contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculating breaking weight in tons from formulæ, $b = 46·65 \frac{D^{3·55} - d^{3·55}}{L^{1·6}}$ $Y = \frac{b\,c}{b + \frac{3}{4}c}$.	Safe weight in tons.	Safe weight if irregularly fixed, in tons.
10	24	5	4	127·84	31·96	12·78
10	20	6	5	189·36	47·34	18·93
10	$17\frac{1}{7}$	7	$5\frac{1}{2}$	359·07	89·76	35·90
10	15	8	$6\frac{1}{2}$	463·84	115·96	46·38
10	$13\frac{1}{3}$	9	$7\frac{1}{2}$	574·13	143·53	57·41
10	12	10	$8\frac{1}{2}$	687·32	171·83	68·73
10	$10\frac{10}{11}$	11	9	1033·95	258·48	103·39
10	10	12	10	1190·64	297·66	119·06
10	$9\frac{3}{13}$	13	11	1349·25	337·31	134·92
10	$8\frac{4}{7}$	14	12	1508·89	377·22	150·88
10	8	15	$12\frac{1}{2}$	2037·59	509·39	203·75
10	$7\frac{1}{2}$	16	$13\frac{1}{2}$	2239·80	559·95	223·98
10	$7\frac{1}{17}$	17	$14\frac{1}{2}$	2436·66	609·16	243·66
10	$6\frac{2}{3}$	18	$15\frac{1}{2}$	2641·49	660·37	264·14

Table showing the Breaking Weight of Solid Uniform Cylindrical Pillars for different qualities of Cast Iron, both Ends being Flat and Firmly Fixed, and the Safe Weight of same if irregularly Fixed.

Height of Pillar, in feet.	Diameter, in inches.	*For the breaking weight, if firmly fixed.* Co-efficients for strength, in lbs. 78,400	89,600	100,800	112,000	123,200	134·400
		Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
8	2	11·95	13·66	15·36	17·07	18·78	20·49
10	2	8·17	9·34	10·51	11·68	12·85	14·02
10	3	34·50	39·43	44·35	49·28	54·21	59·14
12½	3	23·61	26·98	30·35	33·72	37·10	40·47
12½	4	65·56	74·92	84·29	93·65	103·02	112·38
15	4	48·08	54·95	61·82	68·69	75·56	82·43
15½	5	100·42	114·76	129·11	143·45	157·80	172·15
17	5	85·82	98·09	110·35	122·61	134·87	147·13
17½	6	156·07	178·37	200·66	222·96	245·26	267·55
20	6	124·37	142·14	159·91	177·68	195·45	213·22
		For the safe weight if irregularly fixed.					
8	2	1·19	1·36	1·53	1·70	1·87	2·04
10	2	0·81	0·93	1·05	1·16	1·28	1·40
10	3	3·45	3·94	4·43	4·92	5·42	5·91
12½	3	2·36	2·69	3·03	3·37	3·71	4·04
12½	4	6·55	7·49	8·42	9·36	10·30	11·23
15	4	4·80	5·49	6·18	6·86	7·55	8·24
15½	5	10·04	11·47	12·91	14·34	15·78	17·21
17	5	8·58	9·80	11·03	12·26	13·48	14·71
17½	6	15·60	17·83	20·06	22·29	24·52	26·75
20	6	12·43	14·21	15·99	17·76	19·54	21·32

In Mr, Hodgkinson's edition of Tredgold's *Practical Essay on the Strength of Cast Iron, &c.*, page 26, a table is there given, entitled "A table to show the weight or pressure a cylindrical pillar or column of cast iron will sustain, with safety, in cwts." This table was calculated by the following formula:—

l = length in feet, d = diameter in inches, W = weight to be supported in lbs.

$$\frac{9562\,d^4}{4\,d^2 + \cdot 18\,l^2} = W$$

The following table is an abstract from Mr. Tredgold's, with this difference: the original is given in cwts., and I have reduced it to tons. A note attached to this table by Mr. Hodgkinson, says: "This table has no solid basis. The very ingenious reasoning from which the formula is deduced by which the table was calculated, depends upon assumptions which Mr. Tredgold was induced to adopt through want of experimental data. See Mr. Barlow's Report on the Strength of Materials, 2nd vol., of the British Association."

Table from Tredgold, reduced to Tons.

Diameter in inches.	Length or Height. 6ft.	8ft.	10ft.	12ft.	14ft.	16ft.	18ft.	20ft.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
2	3·00	2·45	2·00	1·60	1·30	1·10	0·90	0·75
2½	5·25	4·55	3·85	3·25	2·75	2·35	2·00	1·70
3	8·15	7·25	6·40	5·55	4·85	4·20	3·65	3·20
3½	11·60	10·70	9·55	8·60	7·80	6·75	5·95	5·30
4	15·50	14·40	13·30	12·10	11·00	9·90	8·90	8·00
4½	20·00	18·95	17·70	16·35	15·05	13·75	12·55	11·45
5	25·05	23·95	22·60	21·35	19·70	18·25	16·85	15·50
6	29·60	28·65	27·50	26·25	24·85	23·45	22·00	20·65

Table from my calculations, being One-twelfth of the Breaking Weight as deduced from Mr. Hodgkinson's formulæ for Solid Pillars of Cast Iron with Flat Ends.

Diameter in inches.	Length or Height. 6ft.	8ft.	10ft.	12ft.	14ft.	16ft.	18ft.	20ft.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
2	2·04	1·25	0·85	0·63	0·48	0·38	0·31	0·26
2½	4·52	2·77	1·89	1·39	1·07	0·85	0·69	0·58
3	8·23	5·30	3·62	2·66	2·04	1·63	1·33	1·11
3½	13·21	9·16	6·27	4·59	3·53	2·82	2·30	1·92
4	19·71	14·19	10·07	7·38	5·68	4·53	3·70	3·10
4½	27·80	20·43	15·30	11·22	8·63	6·88	5·63	4·70
5	37·56	28·13	21·64	16·31	12·55	10·00	8·18	6·84
6	62·23	48·21	38·00	30·55	23·98	19·11	15·64	13·07

Table from my calculations, being One-fourth of the Breaking Weight as deduced from Mr. Hodgkinson's formnla for Solid Pillars of Cast Iron with Rounded Ends, and from calculations based on other of Mr. H.'s formulæ.

2	2·39	1·47	1·00	0·73	0·56	0·45	0·37	0·30
2½	5·42	3·40	2·32	1·70	1·31	1·04	0·85	0·71
3	9·82	6·75	4·62	3·39	2·60	2·07	1·70	1·42
3½	15·75	11·45	8·25	6·05	4·66	3·71	3·04	2·54
4	23·62	17·58	13·47	10·00	7·69	6·13	5·02	4·19
4½	33·30	25·39	19·79	15·58	11·98	9·55	7·82	6·53
5	44·86	34·99	27·71	22·36	17·81	14·19	11·62	9·71
6	73·63	59·70	48·71	40·19	33·59	28·18	23·05	19·28

Table from my calculations, being One-twelfth of the Breaking Weight as deduced from Mr. Hodgkinson's formulæ for Solid Pillars of Wrought Iron with Flat Ends.

2	3·62	2·03	1·30	0·90	0·66	0·50	0·40	0·32
2½	6·96	4·50	2·88	2·00	1·47	1·12	0·88	0·72
3	11·95	8·20	5·50	3·82	2·80	2·15	1·69	1·37
3½	18·67	13·17	9·51	6·60	4·85	3·71	2·93	2·37
4	26·92	19·65	14·59	10·61	7·80	5·97	4·71	3·82
4½	37·00	27·72	20·96	16·13	11·85	9·07	7·16	5·80
5	48·85	37·46	28·83	22·49	17·22	13·18	10·42	8·44
6	77·83	62·09	49·28	39·35	31·79	25·19	19·90	16·12

Table from my calculations, being One-fourth of the Breaking Weight as deduced from Mr. Hodgkinson's formulæ for Solid Pillars of Wrought Iron with Rounded Ends, and from calculations based on other of Mr. H's formulæ.

2	4·02	2·26	1·44	1·00	0·64	0·50	0·40	0·36
2½	8·39	5·23	3·34	2·32	1·70	1·30	1·03	0·83
3	14·86	10·11	6·65	4·62	3·39	2·60	2·05	1·66
3½	23·61	16·66	11·88	8·25	6·06	4·64	3·66	2·97
4	34·75	25·33	18·78	13·63	10·01	7·67	6·06	4·90
4½	48·30	36·27	27·43	21·23	15·60	11·94	9·43	7·64
5	64·27	49·55	38·28	29·95	23·18	17·75	14·02	11·36
6	103·39	83·28	66·69	53·61	43·52	35·23	27·84	22·55

Mr, Hodgkinson gives the following formulæ for the breaking weight of solid cylindrical pillars, both ends being rounded, and the length of the pillars exceeding fifteen times their diameters:—

For cast iron, $W = 14{\cdot}9 \dfrac{D^{3{\cdot}76}}{L^{1{\cdot}7}}$

For wrought iron, $W = 42{\cdot}8 \dfrac{D^{3{\cdot}76}}{L^{2}}$

In the following tables for cast iron pillars with rounded ends, and in succeeding tables for wrought iron pillars with rounded ends, it will be seen how far I have made use of Mr, Hodgkinson's formula, withholding for the present the formulæ I have used for those pillars below 30 diameters.

Tables showing the calculated Breaking Weight and Safe Weight of Uniform Cylindrical Pillars of Cast Iron, both Ends being Rounded or Irregularly Fixed.

Solid Uniform Cylindrical Pillars of Cast Iron, both Ends being Rounded or Irregularly Fixed.

Length or height of Pillar, in feet.	Number of diameters contained in the length or height.	Diameter in inches.	Calculated breaking weight in tons from other formulæ.	Calculated breaking weight in tons from formula. $W = 14{\cdot}9 \frac{D^{3{\cdot}76}}{L^{1{\cdot}7}}$.	Safe weight in tons.
5	30	2	13·05	......	3·26
6	36	2	......	9·59	2·39
7	42	2	......	7·38	1·84
8	48	2	......	5·88	1·47
9	54	2	......	4·81	1·20
10	60	2	......	4·02	1·00
11	66	2	......	3·42	0·85
12	72	2	......	2·95	0·73
13	78	2	......	2·57	0·64
14	84	2	......	2·27	0·56
15	90	2	......	2·02	0·50
16	96	2	......	1·81	0·45
17	102	2	......	1·63	0·40
18	108	2	......	1·48	0·37
19	114	2	......	1·35	0·33
20	120	2	......	1·23	0·30
5	24	2½	26·93	......	6·73
6	28·8	2½	21·70	......	5·42
7	33·6	2½	......	17·06	4·26
8	38·4	2½	......	13·60	3·40
9	43·2	2½	......	11·13	2·78
10	48	2½	......	9·30	2·32
11	52·8	2½	......	7·91	1·97
12	57·6	2½	......	6·82	1·70
13	62·4	2½	......	5·95	1·48
14	67·2	2½	......	5·25	1·31
15	72	2½	......	4·67	1·16
16	76·8	2½	......	4·18	1·04
17	81·6	2½	......	3·77	0·94
18	86·4	2½	......	3·42	0·85
19	91·2	2½	......	3·12	0·78
20	96	2½	......	2·86	0·71

Solid Uniform Cylindrical Pillars of Cast Iron, both Ends being Rounded or Irregularly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	Diameter in inches.	Calculated breaking weight in tons from other formulæ.	Calculated breaking weight in tons from formulæ. $W = 14{\cdot}9 \frac{D^{3{\cdot}76}}{L^{1{\cdot}7}}$	Safe weight in tons.
5	20·	3	47·53	......	11·88
6	24·	3	39·29	......	9·82
7	28·	3	32·60	......	8·15
8	32·	3	......	27·03	6·75
9	36·	3	......	22·12	5·53
10	40·	3	......	18·49	4·62
11	44·	3	......	15·73	3·93
12	48·	3	......	13·56	3·39
13	52·	3	......	11·84	2·96
14	56·	3	......	10·43	2·60
15	60·	3	......	9·28	2·32
16	64·	3	......	8·31	2·07
17	68·	3	......	7·50	1·87
18	72·	3	......	6·81	1·70
19	76·	3	......	6·21	1·55
20	80·	3	......	5·69	1·42
5	17·142	3½	75·32	......	18·83
6	20·571	3½	63·00	......	15·75
7	24·	3½	53·56	......	13·39
8	27·428	3½	45·81	......	11·45
9	30·857	3½	......	39·50	9·87
10	34·285	3½	......	33·02	8·25
11	37·714	3½	......	28·08	7·02
12	41·142	3½	......	24·22	6·05
13	44·571	3½	......	21·14	5·28
14	48·	3½	......	18·64	4·66
15	51·428	3½	......	16·57	4·14
16	54·857	3½	......	14·85	3·71
17	58·284	3½	......	13·40	3·35
18	61·714	3½	......	12·16	3·04
19	65·142	3½	......	11·09	2·77
20	68·571	3½	......	10·16	2·54
5	15·	4	110·57	......	27·64
6	18·	4	94·50	......	23·62
7	21·	4	81·23	......	20·30
8	24·	4	70·32	......	17·58
9	27·	4	61·32	......	15·33
10	30·	4	53·88	......	13·47
11	33·	4	......	46·40	11·60
12	36·	4	......	40·02	10·00
13	39·	4	......	34·93	8·73
14	42·	4	......	30·79	7·69
15	45·	4	......	27·38	6·84
16	48·	4	......	24·54	6·13
17	51·	4	......	22·13	5·53
18	54·	4	......	20·08	5·02
19	57·	4	......	18·32	4·58
20	60·	4	......	16·79	4·19

ABSTRACT OF ENGINEER'S LOG OF THE "GREAT EASTERN." THIRD VOYAGE TO NEW YORK, 1862.

Date each day, ending at Noon.	PADDLE ENGINES. Revolutions of Engines each day.	PADDLE ENGINES. Average Revolutions per minute.	PADDLE ENGINES. Average Pressure of Stm. in Engine-room.	PADDLE ENGINES. Tons of Coal used each day.	SCREW ENGINES. Revolutions of Engines each day.	SCREW ENGINES. Average Revolutions per minute.	SCREW ENGINES. Average Pressure of Stm. in Engine-room.	SCREW ENGINES. Tons of Coal used each day.	Total quantity of Coal used each day.	Number of Knots run by Paddle Engines.	Number of Knots run by Screw Engines.	Distance run by Ship in Knots.	Latitude.	Longitude.	Course.	Barometer.	Observations on Rolling of Ship. Inclination to windw.	Observations on Rolling of Ship. Inclination to leeward	Observations on Rolling of Ship. No. of oscil. per min.	General Remarks.
			lbs.	Tons			lbs.	Tons	Ton	K.	K.	K.				inches.	deg.	deg.		
May 8 ...	11,684	9·0	20½	113	45,852	36·0	19½	136	249	282	329	292	51·02 N.	11·14 W.	W. by. S.	29·75	3	5	6	At 3.15 P.M. discharged pilot; full speed at 3.30 P.M.
May 9 ...	13,971	9·5	21½	117	51,680	35·3	19½	149	266	346	368	308	50·40 N.	18·51 W.	W. ½ S.	30·50	1	1	4	Strong head wind.
May 10 ...	14,634	9·9	21½	121	53,060	36·0	18	157	278	364	382	296	50·35 N.	26·39 W.	W.	30·32	2	3	5	Strong head wind.
May 11 ...	14,826	10·2	21½	116	52,020	36·0	17½	156	272	361	378	280	50·10 N.	34·15 W.	W. ¾ S.	30·25	2	2	5	Strong head wind; dense fog; standing by engines.
May 12 ...	15,085	10·2	21½	120	52,650	36·5	17½	159	279	366	378	303	48·23 N.	41·19 W.	W. by S.	30·	3	4	6	Strong head wind.
May 13 ...	13,975	9·6	21½	125	51,720	35·5	17½	153	278	346	375	293	46·51 N.	46·52 W.	S. 6¼ W.	30·27	2	2	4	Strong N.W. gale and heavy head sea; engines racing.
May 14 ...	16,651	11·4	21½	133	54,510	37·3	17½	158	291	370	394	324	44·44 N.	53·48 W.	S. by W. ¾ W.	30·12	1	1	3	Dense fog; passed several icebergs; standing by engines.
May 15 ...	16,577	11·4	22	127	53,440	36·6	16¾	158	285	420	384	348	42·43 W.	61·02 W.	W.S.W.	30·40	4	5·5	5·5	Light head wind; passed several icebergs.
May 16 ...	16,774	11·7	20½	116	54,070	37·6	17¾	158	274	370	392	332	40·50 N.	68·02 W.	W. by S½ S.	30·52	2	2	3	Dense fog; stopped engines twice to take soundings.
May 17 ...	13,636	12·0	22	100	42,960	37·7	18½	133	233	339	310	300	...	...	...	30·40	0	0	0	At 8.30 P.M. took pilot on board; at 7.30 A.M. arrived off Sandy Hook.
Total	147,853	10·5	21½	1188	511,970	36·07	18	1517	2705	3564	3690	3076	...	...	...	...	...	...	...	Actual time steaming, 9 days, 18 hours, 45 minutes.

The number of knots run by the paddle-wheel (taking the extreme diameter as effective, viz., 50ft. = 151ft. each revolution) from the 8th May to the 17th May inst. were registered as follows:—282, 346, 379, 375, 381, 358, 430, 426, 440, 351 knots; indicated horse-power of paddle engines, 3411; indicated horse-power of screw engines, 4886; density of water in boilers $1\frac{5}{8}$; vacuum in paddle engines, 25·5; vacuum in screw engines, 25·5; extreme diameter of paddle wheels, 50ft.; effective diameter 48ft. = 150·79ft. each revolution; pitch of screw, 44ft.; immersion on leaving Milford 23ft. 3in. forward, 26ft. 8in. aft.; immersion on arrival at New York, 19ft. 6in. forward, 25ft. aft.; slip of paddle wheels 12·6 per cent.; slip of screw, 20·3 per cent.; average daily consumption of coal by paddle engines, 119 tons; ditto by screw engines, 152 tons; total daily consumption, 271 tons.

(Signed) J. RORISON, Chief Engineer.

ABSTRACT OF ENGINEER'S LOG OF THE "GREAT EASTERN." SECOND VOYAGE FROM NEW YORK TO LIVERPOOL, MAY AND JUNE, 1862.

Date each day, ending at Noon.	PADDLE ENGINES. Revolutions of Engines each day.	PADDLE ENGINES. Average Revolutions per minute.	PADDLE ENGINES. Average Pressure of Stm. in Engine-room.	PADDLE ENGINES. Tons of Coal used each day.	SCREW ENGINES. Revolutions of Engines each day.	SCREW ENGINES. Average Revolutions per minute.	SCREW ENGINES. Average Pressure of Stm. in Engine-room.	SCREW ENGINES. Tons of Coal used each day.	Total quantity of Coal used each day.	Number of Knots run by Paddle Engines.	Number of Knots run by S nes	Distance run by Ship in Knots.	Latitude.	Longitude.	Course.	Barometer.	Observations on Rolling of Ship. Inclination to windw.	Observations on Rolling of Ship. Inclination to leeward	Observations on Rolling of Ship. No. of oscil. per min.	General Remarks.
			lbs.	Tons			lbs.	Tons	Tons	K.	K.	K.				inches.	deg.	deg.		
May 31 ...	...	...	...	18	...	...	...	26	44	...	...	...	...	...	...	...	...	...	...	At 10.25 A.M. started engines ahead slow; at 10.50 stopped engines; at 11.30 dropped anchor off quarantine ground.
June 1 ...	...	...	...	34	6,940	36·6	17	50	84	...	...	...	...	...	...	...	...	...	...	At 8.30 A.M. started engines; at 10.35 discharged pilot.
June 2 ...	15,069	10·7	22	112	51,530	38·0	17½	143	255	376	377	360	40·33 N.	66·14 W.	E. 1° N.	30·26	...	...	...	Light beam wind; sea smooth; fore and aft sails set; 10.45 full speed.
June 3 ...	15,726	11·1	22	131	53,690	38·0	17½	152	283	385	387	350	41·56 N.	58·36 W.	E. by N. ¼ N.	30·30	1	1	2	Dense fog; sea smooth; fore and aft sails set.
June 4 ...	15,650	11·2	22	128	53,120	37·0	15½	152	280	390	383	348	43·18 N.	50·42 W.	E. by N. ¼ N.	30·30	2	2	3	Dense fog; standing by engines.
June 5 ...	15,363	11·0	20½	129	51,550	36·5	15½	141	270	381	373	345	45·50 N.	45·54 W.	N.E. by E. ¾ E.	30·20	2	2	3	Beam wind; fore and aft sails set; coals running very small.
June 6 ...	15,279	10·7	20	121	52,050	37·0	15¾	150	271	380	375	312	47·30 N.	39·12 W.	E. by N. ¾ N.	29·95	3½	5	6	Strong N W. wind; fore and aft sails set.
June 7 ...	15,055	10·7	18½	132	52,460	38·5	16½	179	311	376	377	325	49 4 N.	31·39 W.	E. by N. ¾ N.	30·00	3	5	6	Fresh breeze N.W.; fore and aft sails set.
June 8 ...	15,628	11·1	18	132	54,230	38·4	15¾	161	293	385	391	335	50·13 N.	23·28 W.	E. by N.	30·30	5	7	6	Light beam wind; fore and aft sails set.
June 9 ...	15,939	11·4	18	132	54,020	38·2	15½	151	283	402	392	324	50·38 N.	15·23 W.	E. ¼ N.	30·30	1½	2½	4½	Light beam wind; coals running very small, and bad in quality.
June 10 ...	16,223	11·5	17½	139	53,910	38·2	15½	179	318	402	390	328	51·46 N.	7·52 W.	E. ½ N.	30·00	2	2	3	Beam wind; coals running very small, and of bad quality.
June 11 ...	9,378	11·4	16	89	32,070	38·0	16	170	259	402	387	215	Steering by the land.			29·89	1	1	2	At 2.30 A.M. stopped engines to take pilot on board.
Total	149,310	11·0	20½	1287	515,570	37·4	16¾	1654	2941	3883	3832	3242	...	...	...	...	...	...	...	Actual time steaming, 227 hours = 9 days 11 hours.

Indicated horse-power of paddle engines, 3600; indicated horse-power of screw engines, 4656; total 8256 horse-power; density of water in boilers, $1\frac{5}{8}$; vacuum in paddle engines, 25; vacuum in screw engines, 25·5; extreme diameter of paddle wheel, 50ft.; effective diameter 48ft. = 150·79ft. each revolution; pitch of screw, 44ft.; immersion on leaving New York, 25ft. forward, aft. 25ft. 6in.; immersion on arrival at Liverpool, 21ft. forward; aft. 23ft.; average daily consumption of coals by paddle engines, 137 tons; ditto by screw engines, 170 tons; total daily consumption, 307 tons; slip of paddle wheels, 19¾ per cent.; average distance run, 14¼ knots per hour.

(Signed) T. RORISON, Chief Engineer.

FIRST VOYAGE.—ABSTRACT LOG OF THE AFRICAN ROYAL MAIL STEAMER "MACGREGOR LAIRD," A. J. M. CROFT, COMMANDER, FROM LIVERPOOL TO MADEIRA.

Date. 1862.	Winds.	Course and Distance.	Revolutions. Average per min.	Speed. Average per hour.	Coals expended in 24 hours.	Coals Remaining at Noon.	Distance run per Ton of Coals.	Temperature of Engine Room.	Temperature of Stoke Room.	Vacuum.	Steam Pressure, in lbs.	Hours Sails Set.	Remarks.
					T. C. Q.	T. C. Q.		Deg.	Deg.			H. M.	
April 25	S. Westerly.	Variable, 182	32·3	9·1	11 11 2	618 8 0	28	60	75	27½	25·5	6 30	Fresh head wind throughout. Five tons of coal allowed here for coming into the river.
„ 26	S.W.	S. 26° W., 220	32·0	9·2	7 18 0	610 18 0	28	65	79	27½	24·7	9 0	Moderate head winds; at times carrying fore and aft sails.
„ 27	S.W. & Var.	S. 21° W., 203	34·5	8·5	9 1 0	601 17 0	23	77	98	27½	28·4	9 0	Moderate head winds; at times carrying fore and aft sails.
„ 28	Easterly	S. 20° W., 265	36·6	11·0	10 14 0	591 3 0	25	80	101	27	28·5	24 fore & aft 14 square	Strong gale from the eastward, with very heavy sea. Ship very steady considering the state of the sea and weather.
„ 29	S.S.W.	S. 26° W., 208	35·8	8·7	9 14 0	581 9 0	21½	76	96	27	29·5	13 fore & aft 6 square	Moderate and variable, and at times head wind.
„ 30	W.N.W.	S. 13° W., 247	35·5	10·3	10 5 0	571 4 0	24	78	97	27	29·7	20 all	Fresh breeze, sails set the greater part of the day.
May 1	Variable	120	37·0	10·0	5 0 0	566 4 0	....	......	....	....	....	....	At 1 a.m. on the 1st anchored in Funchal Roads, Madeira.
		1,445			64 3 2								

Average Speed during the passage, 9·5 knots.
Average Consumption of Coals—Engines Account, 9 tons 10 cwt.
Average Revolutions per minute during the passage, 34·9.

Average Pressure of Steam, 28 lbs., nearly.
Average Vacuum, 27¼.
Average distance run per ton of Coals, 25 miles.

(Signed) A. J. M. CROFT.

DIMENSIONS, &c., OF THE SCREW STEAMER "MACGREGOR LAIRD."

Length.. 245 feet.
Breadth .... 30 „
Depth .... 21 „
Engines .... 200 H. P., nominal.

Displacement on Voyage .... 2,035 tons.
Midship Section—Area.. 440 „
Draught of Water Amidships .... 17 ft. 2 in.
Dead weight on board on leaving Liverpool .... 1,100 tons.

INSTITUTION OF ENGINEERS IN SCOTLAND.

ON MOVABLE BRIDGES.

By Mr. D. M'Call.

Illustrated by Plate 218.

The subject of movable bridges is brought before this Institution, not because anything very new or original is to be introduced or explained: but it is presumed that it will not be uninteresting to glance at some of the prominent features of such bridges, at some of the improvements which have lately been made upon their construction, and at the merits of each kind of movable bridge in certain situations.

Under movable bridges may be classed draw or lift bridges, swing bridges, floating or pontoon bridges, and telescope bridges; but at present the subject shall be confined to draw and swing bridges, which are the only movable bridges adopted to any great extent in this country for permanent use.

At first, in crossing the ditches round fortresses, draw-bridges consisted of a simple wooden platform, which was fastened at one end to a beam laid horizontally, and parallel to the sides of the opening to be crossed, or to the top of a stone wall or abutment by means of strong hinges. The platform was acted upon at its other extremity by levers, or by chains, worked either by wheels or by hand, and thus raised to the vertical position when necessary.

When ship canals were introduced into this country about a century ago, it was requisite to have movable bridges for all roads which crossed over the navigations. Draw-bridges of a simple construction were often used for this purpose. The platform was generally divided into two equal parts, each revolving on a horizontal axis, and raised by means of chains passing over pulleys, which were wound up by wheel gearing. Afterwards the back-balance was added, and which is now one of the principal features of a draw bridge. The equilibrium being perfect, friction is the only thing to be overcome in raising or lowering the platforms, and this is generally effected by means of a pinion working into a circular rack, which is fixed to the sides of the bridge.

Draw-bridges are also used for crossing locks and dock entrances at many of our harbours, and some of them are of considerable dimensions.

The abutments of these bridges are generally of masonry. The chambers or wells for the counter-balances are sometimes formed by inserting into the stonework of the abutments cast-iron boxes; but these wells can be made perfectly water-tight by ashlar masonry set in hydraulic mortar. The platforms were at first nearly always constructed of wood, and afterwards many were made of cast-iron; but during the last ten or twelve years several large lift bridges have been constructed with wrought-iron girders and cross braces.

The draw bridges over the Forth and Clyde Canal, have been in daily operation for many years, and number about forty; they are from 20 to 22 feet in span between the faces of the abutments, and from 10 to 14 feet wide, the platform of each being in two leaves. The axles are of cast-iron, with sockets in front, into which the timber joists are fitted, and with arms behind, to which the back-balance is fixed. The axles revolve on cast-iron bearings, and each half of the bridge is raised by means of suitable gearing. The timber joists are covered by two layers of planking, and the sides are protected by wooden fences. These bridges are very easily worked by two men, one on each side of the canal.

The draw bridge at the London Commercial Docks, Fig. 11, Plate 218, is 48 feet span in the clear, and was erected from a design by Messrs. Walker

& Burgess, in 1853. The platform is also in two parts, each having four wrought-iron girders 43½ feet long, firmly bound together by cross wrought-iron braces and ties. A cast-iron axle 12 inches square is firmly fixed to them, and revolves in plummer blocks provided with brass bushes. Kentledge boxes are fixed to the landward ends of the girders, and between them, for the counter-balance, which is 10 tons in weight, for each half of the bridge. The girders are covered with two layers of planking in the usual way, and the bridge is raised by the gearing at each side of each leaf, four men being required for opening the bridge.

Swing bridges are now extensively used at harbours, and for crossing inland navigations, both for roads and railways. The abutments are generally of masonry, but in many cases they are constructed of timber. The platforms of swing bridges, until lately, were usually of timber framing or of cast-iron girders, tied together and covered with planking. To the under side of the platform was fixed a cast-iron ring or roller path, and a similar ring was fixed to the abutment, the surfaces being inclined for the rollers. Between these rings were placed from ten to twenty conical rollers set in a cast-iron frame or live ring at equal distances. These rollers were generally from 6 to 18 inches in diameter, and from 6 to 12 inches broad. The concentricity of all the rings was preserved by means of a centre pin. The rollers were usually of chilled iron, but sometimes of brass, and on them the whole weight of the bridge was placed. The friction was thus considerable, and powerful gearing, worked by at least two men to each leaf, was required to open and shut all bridges, but those of the smallest and lightest description.

There are many fine examples of these bridges of large dimensions at our principal harbours, and which reflect credit on their designers and constructors.

Swing bridges for roads were nearly always formed in two movable leaves; but when railways began to intersect the country, it was necessary to modify or improve such bridges, so that a rigid platform for the passing train could be obtained in crossing the numerous navigations, for which it was essential to have head-room for masted vessels. To get this rigidity, swing bridges of one leaf have been generally adopted, and these have been made either of cast or wrought-iron. The bridge over the river Rother, on a branch of the South-Eastern Railway, is a good example of a cast-iron swing bridge, the girders of which are 112ft. long, each weighing 24 tons, and made up in four lengths.

The bridge near Falkirk, designed by Mr. A. J. Adie, for carrying the Stirlingshire Midland Junction Railway over the Forth and Clyde Canal, is an admirable example of a malleable-iron swing bridge. In the former, the whole weight of the bridge is on sixteen conical rollers; in the latter, the greater part of the weight is on a steel ball, supported by a centre pivot; and the remainder of the weight is on conical rollers, with upper and under rings or roller paths. This bridge is easily worked by two men, and the platform is made rigid by means of four strong screws, which are turned by geared shafting. There is also a centre screw, by which the whole weight can be placed on the steel ball, and the platform adjusted. The iron work and platform of this bridge cost about £1000.

As in engine turn-tables, improvements have been introduced, which have simplified and cheapened the construction of swing bridges, and have rendered the working of them easy and expeditious. The recent improvements are—1st. Making the framework of wrought-iron instead of cast-iron, and thus reducing the weight of the platform, and correspondingly the back-balance. 2nd. Putting the whole weight, or nearly the whole, on a centre pivot, capped with a steel ball, working into a steel socket. 3rd. Having only four or six narrow-rimmed wheels, with axles working in journals, and which are used merely to keep the platform horizontal, instead of a large number of conical rollers. By these and other minor improvements not only is the friction reduced to a minimum, but the construction is much simplified and cheapened, for the live roller frame and upper path are done away with altogether, and bridges of moderate size can easily be worked by one man.

A swing bridge into which these improvements have been introduced, and which is represented at Figs. 1 to 7, has lately been erected from drawings made out by and under the superintendence of the author, for carrying the Twecher and Neilston Railway, belonging to Messrs. William Baird and Co., over the Forth and Clyde Canal, near Kilsyth. The clear span of this bridge is 25ft., and the width of platforms 11ft. The abutments are constructed of timber piles, tied and braced together, and covered with planking. On the south abutment are fixed the centre pivot, and the cast-ring or wheel-path, which is 11ft. diameter. The moving platform consists of two wrought-iron girders, each 45ft. long, by 2ft. in depth at the pivot, and 14in. at the outer extremities. These girders are constructed of plates and angle-irons rivetted together in the usual manner. Over the pivot the girders are joined together by a strong cast-iron cross girder, made hollow at the centre, to encompass the pivot. To the top of this cross girder at the centre is fitted a strong cap, into which a steel socket is fitted. This socket works on the steel ball, which is a semisphere 7in. in diameter at the base; and the cap is fixed to the girder by six 1⅞in. screw bolts, by means of which the bridge can be raised or lowered a little for adjustment, and by which the whole weight of the platform can be put on the pivot. The longitudinal girders are farther tied together by two cast-iron and three wrought-iron cross girders. To the ends of the cast-iron cross girders, along with the web of the longitudinal girders, the wheel bearings are fixed by screw bolts. The four wheels are of cast-iron, 18in. in diameter, with rounded tires 2in. broad. The axles are of malleable-iron 2¼in. in diameter, and revolve in journals placed close to the main girders. The bridge is covered with planking 4in. thick, and the rails are laid upon the longitudinal timber beams, which rest on the planking right over the girders. The bridge is opened and closed by simple gearing; the lower pinion working into a circular rack, which is cast upon a part of the ring or wheel track. The ends of the girders swing over the abutment plates and about one inch clear of them; but to bring the platform to a solid bearing upon the plates, a wrought-iron wedge, 9in. broad, which slides in a grooved frame fixed to the bottom flange at the end of each girder, is driven tightly between the girder and abutment plate by means of handles, levers, and connecting-rods; and by the insertion of the four wedges the platform is made perfectly rigid. The bridge has a self-acting catch or lock to fix it when either closed or opened. The back-balance weighs 13 tons, and consists of square blocks of cast-iron, placed on the plates between the girders behind the pivot. A considerable mineral traffic has passed over this bridge during the last eighteen months, and it has been found to answer the purpose satisfactorily. It is easily opened or closed by one man in 60 or 70 seconds. The movable platform, including all the iron work, cost about £300, and the abutments about £470.

It only remains now to allude briefly to the advantages and disadvantages of draw and swing bridges in certain positions.

Drawbridges are very suitable for crossing the entrances and locks at harbours, where ground is limited and valuable, for all their parts are confined within the roadway, whereas in swing bridges when open, the platform covers ground or waterway of its own dimensions, which may not in many cases be easily given up for this purpose, as at the crowded docks of London. Draw bridges are therefore still being adopted there, for besides the large one erected at the Commercial Docks in 1853, already referred to, and which has since worked perfectly satisfactorily, another wrought-iron draw bridge, 34 feet span, has been opened for traffic two weeks ago by the same engineers at the same docks. A similar bridge was also erected over the harbour of Great Yarmouth, 50 feet span, in 1854.

Several cast-iron lift bridges were erected over the entrances to the Hull docks, forty-five years ago, and are still in good working order. At many other places they have been adopted with advantage. Their adaptability to dock purposes is worthy of consideration by engineers, where a large portion of the traffic, as in London, consists of barges passing out and in, in which case it is only necessary to raise the bridge a little to allow the barge to pass; whereas in a swing bridge, the leaf would require to be turned nearly full round, occupying much time.

However, in many cases, draw bridges are now being superseded by swing bridges. The principal advantages of the latter are the simplicity of their construction, the working parts being all above the abutments, and readily got at, and consequently more easily kept in repair; and their suitableness for railway purposes, for draw bridges being nearly always in two leaves, it is difficult to make them rigid enough for a passing train; and for roads over canals or other inland navigations, they are not so convenient or so economically worked.

At present on inland navigation where draw bridges are in use, as on the Forth and Clyde Canal, one permanent bridge keeper is sufficient for each bridge, the leaf on the towing path side being raised by the horse driver, but when steam-power on canals becomes universal, as is likely to be the case, two bridge keepers will be needed to work each of the draw-bridges, otherwise a man from the steamboat must leap ashore at every bridge for the purpose of raising one half of it; a practice which will both cause delay and be dangerous.

The equilibrium of a draw bridge is often interfered with by surface water running into the counter-balance wells, and by the wooden platforms becoming soaked with rain or dried by the sun's rays. In a swing bridge the exact equilibrium is not of so much consequence, for any small over-weight on one end is easily borne by the wheels.

It may therefore be expected that the day is not far distant when swing bridges will take the place of draw bridges on all inland navigations on which moveable bridges are required; and even for harbours they are generally found to be better suited for crossing locks and entrances to docks and basins.

This subject has been brought forward so that the merits and demerits of swing and draw bridges may be considered and discussed, and not without the hope that the engineering knowledge and skill of many of the members of this Institution may suggest to them improvements which may still further simplify and economize their construction.

In the discussion which ensued, Dr. Rankine said there was another class of bridges, on the telescope principle, of which he had seen no account published in detail. In 1847 he had examined one on the South Coast Railway, near Arundel, which worked satisfactorily. It was designed by the late Mr. Rastrick, and in Fig. 8 a sketch of it is given. The clear span of the bridge across the river Arun is 60 ft. The main platform, carrying a single track of rails, is 140 ft. long and 15 ft. broad, and is supported by suspension from a pair of timber trussed girders of the design shown in the figure. The whole of the timber framework is in scantlings of 1 ft. × 1 ft., except the smaller uprights, which are 8in. × 8in. Each of the four sloping tie-beams, by which the ends of the platform are hung from the central standards, has a pair of flat wrought-iron bars running along its sides. These bars measure 3in. × ⅝in., and are the true ties, the timber beam serning only to stiffen them. In like manner, each of the smaller uprights, A, has alongside of it a pair of iron straps, measuring 2 in. × ⅝in., and these are the true suspending pieces by which the platform is hung from the trusses, the timber uprights serving only to stiffen them. On the other side of the longitudinal timber sole-beams are a pair of inverted rails, which rest upon seven pairs of wheels 5 ft. in diameter. Those wheels are supported by fixed timber frame-work. Under the centre line of the platform is a fixed longitudinal rack, teeth upwards, supported by a timber frame. Into that rack, there gears a pinion on a transverse shaft, carried by the platform. That shaft is driven through two trains of wheelwork by two winches, C, one at each side of the middle of the platform. The side platform, D, for filling up the space between the main platform and the fixed track when the bridge is shut, is carried by ten wheels 3 ft. 6 in. in diameter, which run upon fixed transverse rails. To the best of his remembrance it took two men about twenty minutes to open and shut the bridge. The framework appeared to him to have a considerable excess of strength, and consequently of weight, above what was necessary for safety.

Dr. Rankine also drew attention to a bridge which was in use in Holland, for very narrow spans. It was remarkable for simplicity and lightness, He had not seen the bridge itself, but only a drawing. It was only suitable for a railway, as it had no platform in the space between the two beams which carried the rails.

It is represented in figs. 9 and 10. At A and B were two heel-ports, resting on pivots at their lower ends, and turning-in collars near their upper ends. A pair of beams. AC, BD, are carried at one end by the heel-ports, and are supported also from below by oblique struts abutting against the heel-ports: whilst links, E, keep the beams parallel, like the bars of a parallel ruler. The full lines and unaccented letters show the position of the beams when shut and spanning the canal; the dotted lines and accented letters, their position when opened, when they fit into a recess made at one side of the canal to receive them. Each of the parallel beams carried a rail, so as to form a single track when shut. The bridge is suitable for a railway crossing over a very narrow canal.

SCOTTISH SHIPBUILDERS' ASSOCIATION.

ON THE CONDITIONS AFFECTING STEAMSHIP ECONOMY.

By Mr. Orme Hammerton.

(Continued from page 135.)

To state a maximum economical speed of piston under all circumstances would entail more labour than the limits of this paper will admit, though well worth any sacrifice; but without making any very elaborate investigation into the matter, it appears that a speed of piston represented by the equation

$$\frac{V^2}{2g} = 1$$

would be a decided improvement. This would represent a speed of piston of little more than 481 feet per minute; and one advantage of this increase of speed would be the increased accumulated work in the piston, which would assist the regularity of the machinery, and tend materially to lessen the weight of the engines and gearing, if not of the boilers themselves. The speed of marine engine pistons has been gradually increasing, and cases occasionally occur where 420ft. and 430ft. per minute is obtained. But the most remarkable part of it is, that these good results are exceptions, and not rules. If a case in point be supposed—cylinder 70in. diameter, speed 266ft. per minute—the work of the resistances must always equal the power developed when working at a mean velocity; the accumulated work in the piston is simply found by first eliminating the point in the stroke when the speed of piston is a maximum; and this occurs when the steam, expanding itself, is just equal to the work of resistance, and takes place when $P x = P_1 l$. And since P in this case = 11·38lbs., and P_1 = 23lbs., we have $x = \cdot363\ l = \cdot18$, as the point from admission at which the velocity of piston is maximum, and the pressure at this point, by diagram No. 10, = 11·38lbs. It follows that if the mean pressure at the point of maximum velocity is equal to the opposition caused by the resistances, the mean pressure previous to this point is greater, and in this case = 19·6lbs. Consequently the work developed up to point x = 92,050 units, and the work required to overcome resistance = 52,905 units. The difference, therefore, between these two quantities is the work accumulated in the piston, and = 39,146 units. And this amount determines the maximum velocity of piston. In this instance from formula

$$\frac{V^2 W}{2g} = U,$$

where U = accumulated work, W, work of resistances, referred to speed of piston. Solving for V, we have

$$V = \sqrt{\frac{2 G U}{W}} = 4{\cdot}4$$

velocity of piston per second = 266·5ft. per minute. If the resistances remained constant, in reference to the speed of piston, increased to 481ft., we should obtain, solving for V, since

$$\frac{V^2}{2g} = 1. \quad W = U;$$

that is, the work of resistances and accumulated work are equal; whereas in the first case the accumulated work was only ·7399 of the work of resistances. Solving for W would give the converse result, still showing the equality. This increased accumulated work would, however, tend to produce a diminished consumpt of steam, and, which would be the proper application of the economy, diminished diameter of the cylinder, carrying the steam the proper distance over the stroke, but saving in point of volume of steam and weight of machinery.

Perhaps the objections that exist to a high speed of piston, on account of too rapid expansion, appear greater than they really are, though probably the speed of piston might alter the appearance of the expansion curve of the diagram somewhat. But I am decidedly inclined to consider any great variation attributable to deficient portway, at least in most cases, as it is scarcely to be expected that the same area of portway will suffice a given area of piston at 100 and 400ft. per minute: yet steam passages are made, for high speed, very restricted in area, and opening a small portion only of that area for admission of steam. It would probably be impossible to increase the speed of pistons already constructed to any such extent as that herein proposed; but very little alteration need be made in the construction of new machinery to admit of the innovation. The principal difference would be the portage, which is inadequate, according to present practice, to meet the demands of the piston's motion.

The bearing surfaces would also require extension; but the result I anticipate would justify the means. Everything would be lighter and equally effective; and if the speed of piston were doubled, as the proposed system would seem to demand, the power being represented by the formula

$$\frac{a p f}{33{,}000},$$

if f be doubled the power exerted is doubled, and that in the same cylinder and with the same weight of material; of course, the consumpt of steam increases in proportion to the increase of power; but when a certain power only is required, it is then evidently possible to reduce the size of cylinder and consequently the weight of material; and this decrease of weight is obtained by the increased speed of piston.

It is important to observe that two different methods of increasing the speed of pistons are practicable, with a view to a greater development of power in steam engines—the one, by an increase of pressure in the absolute sense; the other, by an increase of pressure in the relative sense. In the former case it is evident, although we attain the object, it has to be accomplished at the expense of extra material and consequent weight, which is directly opposed to the advantageous application of speed advocated in this paper, and has a tendency, therefore, rather to increase than diminish the evil. If, however, the expansion and resistances be arranged upon the proposed principles herein described, any judicious increase of pressure will produce a superior effect. The method of increasing the speed of piston to that represented by the formula must be perfectly understood to refer to the second method, namely, relative increase of pressure, or, which is equivalent, reduction of the effect of the resistances upon the power, so that at any instant the labour of the piston will be less, and consequently have a correspondingly increased velocity. This method of increasing the speed of piston has a parallel in the case of ordinary gearing, where the strength of shafting, &c., always varies in the inverse ratio of the velocity of revolution, as, for instance, in geared marine engines the propeller shaft is always lighter than the engine shaft, on account of its greater velocity. If, therefore, by increasing the velocity of the engine shaft to that of the pinion shaft, we can dispense with the cumbersome wheel and pinion, and keep the line of shafting the size of the pinion shaft, we certainly gain a great deal; and further, this increase of speed will enable us to reduce the diameter of cylinder and all its connections, and still produce the same power. And this view of the case confirmed me in the opinion that increased speed of piston is necessary, although it first exhibited itself in an investigation of a totally different character. To say that the equation

$$\frac{V^2}{2g} = 1$$

is a limit to the economical speed of piston would be going too far, as it would require considerable investigation to reduce the question to such precise limits, especially as our locomotives maintain a much higher speed than that represented by the formula, and are producing a greater per centage of power per ton of material than any marine machinery afloat, and I am not at present aware of any objection to the speed they attain. The machinery in marine engines, with such quick pistons, would require careful balancing, since the change of direction of motion, especially in heavy engines, would be an insuperable difficulty without this precaution, which attracts attention even in slow-motioned pistons. Perhaps three or more cylinders would be better, at large sizes, than two immense ones, as the strain would be more equally distributed on the shafting; and the rods, &c., whose change of motion forms so formidable an objection to high speeds, would be comparatively lighter, and help to balance each other, on account of the weight being more suitably distributed.

Of course, an objection always exists to the use of three or more cylinders, and that is the increased radiating surface of cylinder and friction surfaces of pistons. For let d = diameter of small cylinders and n = the number of them, then $d^2 n \frac{\pi}{4}$ = area of large one, and $d\sqrt{n}$ = diameter of large one; also the friction of the small pistons

$$= \pi d n$$

and friction of the large one

$$= \pi d \sqrt{n};$$

so that the friction of the large cylinder is to all the small ones as

$$\pi d \sqrt{n} :: \pi d n.$$

The radiating surface also depends upon the same ratio.

Since, however, perfection is only a dictionary word, and we must therefore be content with comparative excellence, of two evils let us choose the least, and sacrifice a little temperature to make so important a modification feasible.

The reduction of weight of machinery, in the absolute sense of the term, is another grand feature in the economical development of the marine interest, which is scarcely yet considered a necessity; and it seems almost impossible to realize the idea that in our future steam-ships cargo will usurp the place of perhaps two-thirds of the cast-iron at present considered necessary for their efficient propulsion. It has been asserted that machinery is made light enough for safety; but fortunately this does not depend upon assertion only, but upon principle. Neither are strength and weight synonymous terms; and by adopting an unit of strength deduced from experiment for the different direction of strains, we can, with rigorous accuracy, determine the amount of material requisite to withstand the impulse of any given amount of force; and as only a certain strain can be applied without producing rupture, it follows, in systems of bodies acted upon by given forces, and acting upon each other, that any addition of so-called strength to any one body in the system, when all are bordering upon rupture, would inevitably produce the total destruction of the system.

Professor Mosely remarks, on the condition of maximum strength with minimum weight, "that the strongest form which can be given to a solid body, in the formation of which a given quantity of material is to be used, and to which the strain is to be applied under given circumstances, is that form which renders it equally liable to rupture at every point. So that when, by increasing the strain to its utmost limit, the solid is brought into that state bordering upon rupture at that point, it may be in the state bordering upon rupture at every other point.

"For let it be supposed to be constructed of any other form, so that its rupture may be about to take place at one point when it is not about to take place at another point, then may a portion of the material evidently be removed from the second point, without placing the solid there in the state bordering upon rupture, and added to the first point, so as to take it out of the state bordering upon rupture at that point, and thus the solid, being no longer in the state bordering upon rupture at any point, may be made to bear strain greater than that which was before on the point of breaking it, and will have been rendered stronger than it was before.

"The first form was not therefore the strongest form of which it could have been constructed with the given quantity of material; nor is any form the strongest which does not satisfy the condition of an equal liability to rupture at every point.

"The solid constructed of the strongest form with a given quantity of material is evidently that which can be constructed of the same strength with the least material, so that the strongest form is also the form of the greatest economy of material."

This beautiful illustration is so absolute and definite that comment becomes superfluous, but unfortunately it requires the aid of the higher branches of mathematical science for its solution, and is therefore a sealed book to many whose time is necessarily otherwise employed, or whose inclination leads them to consideration of a more practical nature. It is too plain, however, that machinery, as at present constructed, is far from satisfying the above condition of maximum economy.

The different weight co-efficients of different engine builders are however, suggestive, and indicate an inclination to improve the efficiency of our steamers by reducing the weights stowed on board for propulsion. If accidents occasionally happen to light machinery, the same occurs with heavy machinery; and certainly more credit is due to those who produce a maximum of power from a minimum of weight, since it is a very easy matter to make machinery so heavy that it will not break. But weight is not strength, but positively weakness beyond a certain point—except every part of the machine is made of strength proportionately increased in which case it just amounts to useless matter, absorbing power to impel its massive proportions through their self-imposed increase of duty. The greatest advantage to the marine interest would accrue from an attentive consideration of this matter, and its investigation is a duty incumbent upon every one interested in steam shipping.

Another great improvement and requirement for economical propulsion is the application of efficient surface condensation, the results of the re-introduction of which principle shows the advantage so conspicuously that no argument is necessary.

The extra weight required in the construction of these condensers is not an objection, since it is of use, and adds to the efficiency of the machinery, and doubtless a more extended experience in their manufacture will suggest simple means for reducing their weight at least to the standard of the injection condensers, or nearly so. The theoretical saving of coal is somewhat incredible, and the practical results hitherto obtained are beyond the expectations of the most sanguine. Diagram Fig. 9 is taken from the engines of a screw steamer fitted with super-heater and surface condenser; it also entirely resembles the figures obtained from the engines of a sister vessel from the same lines, but with injection condenser. The machinery was in other respects precisely similar. The time taking over a voyage of 9000 miles by the vessel with surface condenser was 1030 hours, and the consumpt of coal was 474 tons. The time of the vessel with injection condensers was 1049 hours, and consumpt of coal 642 tons, showing an actual saving of very nearly 25 per cent; a practical result of six weeks' steaming, and not merely a trip on a measured mile.

However, we have not yet, perhaps, arrived at the maximum economy of condensation; and it is to be hoped we shall not again relapse into the old system of injection condensers, as was the case many years ago, when the same principle failed for want of the practical advantages which we possess.

Superheating for further economy, in the next place, must be prosecuted with determination; not that excessive superheating is necessary, or perhaps advisable, but that data may be furnished, and tabulated so as to indicate the probable direction of the maximum advantageous heat of steam for practical purposes. Heat must be taken care of, as the greatest part of the expense of steam machinery consists in generating and maintaining it, and its subtle nature requires the greatest caution in restraining its vagrant tendencies. Cylinders must be jacketed, despite the many practical difficulties that oppose their re-introduction: anything in reason can now be effected by the experience in manufactures of which time and opportunity have made us masters.

Perhaps Mr. Joule's theory would throw some light upon this subject, and might very advantageously be made the basis of a more abstract consideration of the question for another paper. Hitherto, however, this theory has not become so generally accepted as its importance would seem to demand. He asserts that in some of the best cases not above $\frac{1}{8}$th of the heat applied in the furnaces is utilized.

The consideration of the subject of expansion suggested the following method of approaching the geometry of the slide valve; premising the following remarks by stating that it includes the correction due to by angularity of the connecting-rod, which is usually arrived at the working models. (Plate 215.)

Diagram Fig. 8 represents the application of the system I am about to describe. Let A, B, C be the ports on the valve face, O the crankpin, and B the centre of shaft; and let a circle be described representing the path of the crank-pin centre.

Let this circle be divided diametrically into 10ths, and lines drawn through these points at right angles to the centre line X S; and suppose, in the first instance, the length of connecting-rod to be infinity, bisect O Q in M, and with centre M and distance M O describe circle B R O, and join O ·1, O ·2, O ·3, &c., cutting circle B R O in N_1, N_2, N_3. From B draw B ·1, B ·2, &c., cutting circle B R O in N_1, N_2, N_3, &c., then will B N_1, B N_2, &c., = cover, and N_1 ·1, N_2 ·2, &c., = portway, irrespective of travel of valve or piston, being ratios only. To take the case trigonometrically, it appears that the cosine and versine of ½ the arc = the cover and portway respectively. Let the crank-pin be required to travel through 90° previous to cut-off, then, since cosine and versine of ½ the arc are cover and portway respectively, take a travel of valve of $6\frac{1}{8}$ inches; then

As rad.	log. =	10·000000
: cos. 45°	„ =	9·849485
:: travel $6\frac{1}{8}$	„ =	0·787106
: cover	=	0·636590 = 4·3312 inches.

And, therefore, since travel = 6·1250
and cover = 4·3312

the consequent portway = 1·7938 inches.

or in that ratio to the cover.

The portway is frequently made ⅗ of the total opening, and the opening for admission is what is here referred to.

The connecting-rod, however, in general cases so far disturbs the relative motion of the valve and piston as to render the foregoing formula incomplete, and it is evident that the amount of disturbance depends upon the length of connecting-rod.

To accomplish this correction, take D as a centre, being ⅗, or any other proportional amount of opening. At P, the edge of the port, draw P K perpendicular to X S, and with centre D and radius O B describe any arc X Y Z; with same centre D and radius B N_5 describe another arc, cutting P K in E. Join D E, and let D E be produced, cutting arc X Y Z in N_5. From N_5 let fall the perpendicular N_5 L on X S, then P L = cover for valve to cut-off after 90° has been performed by crank-pin. Take the same method of construction with the crank-pin position, when the piston is in the centre of its travel, and draw the diagonal of ratios with centre D, and letting fall a perpendicular on X S from the intersection of the line of ratios with the arc X Y Z, which will result in obtaining some point W. If the ½ of the difference between P L and P W be added to the one end and subtracted from the other, the valve will perform correctly, so far as cover goes, which, however, is not usually necessary, except in horizontal engines; the lead will be slightly disturbed, but not to an extent which would be prejudicial to the effective performance of the machinery. Although I have submitted this system of arranging the slide valve I by no means advocate the use of the ordinary slide, but prefer the adoption of the gridiron valve actuated by tappets, being a more economical and keen working mechanism than the usual slide wrought by an eccentric. The superiority of these valves is evinced by indicator diagrams (See Figs. 9, 11, 20) taken from engines applied with them. They have long been favourites for expansion valves, and are fast superseding the slide valve for all purposes. But in using the ordinary slide, and adopting the amount of cover indicated by the diagram, it will be imperative to make the ports wider and shorter for early cut-off, to prevent an almost impracticable travel of valve. In condensing the present paper, it is evident how many things we have to attend to in the construction of a really economical steam engine,—the best practical pressure to be employed—the amount of expansion due to such pressure—the maximum speed of piston for economy—the production of perfect surface condensers—the amount of super-heating for the maximum effect—the reduction of weight—the regulation of strength and disposition of material,—each of which items would form sufficient material for a much more extended paper than the present one; at least all of them require our most careful attention if we desire, and would attempt, to advance the position of engineering as a science, and help to make way for the much required reform in a steamship economy.

INSTITUTION OF CIVIL ENGINEERS.

ON RECLAIMING LAND FROM SEAS AND ESTUARIES.

By Mr. James Oldham M. Inst. C.E.

It was remarked that, considering the character of the River Humber and its tributaries, and the nature of the soil and the geological formation of the district, it was not surprising that the foreshores, except where efficiently protected by artificial works, should be easily washed away, and the water become loaded with a vast mass of earthy matter, to be again deposited in less disturbed situations. In addition to these natural deposits, the surface of the low lands was frequently raised, and rendered available for cultivation, by a system of "warping," the common process of which was described, such as had been practised on the Trent, the Ouse, and the Don.

The degradation of the land on the whole of the sea coast of Holderness, from Bridlington to the Spurn, was then pointed out. It was found, by observations extending over a considerable period, that on 40 miles of coast, the loss amounted on an average to $2\frac{1}{4}$ yards per annum; but the progress was far from uniform, in some places no change being perceptible, and in others as much as 10 or 15 yards disappearing in twelve months. As bearing on this branch of the subject, an extract was given from a Paper, which was read at the Meeting of the British Association in 1853, "On the Character and Measurements of Degradation of the Yorkshire Coast," by Dr. J. P. Bell.

The phenomena of tidal deposits and accretions in the formation of new land having been explained, it was shown that the greater part of Sunk Island, and of the immediate locality, had accumulated during the last seventy or eighty years. This island was situated at from 7 to 11 miles from the Spurn, on the north band of the estuary of the Humber, having a line of coast of about $6\frac{1}{2}$ miles. It contained 7,000 acres of enclosed land under cultivation, the property of the Crown; and adjacent to it, and forming an addition to the mainland of Yorkshire, there were about 3,000 acres of rich alluvial soil. The accretions in the Humber and on Sunk Island were found to rise, until the surface of the land was coincident with the average level of all tides. When this point was attained, marine plants appeared; and as soon as the surface of salt water accretions was covered with vegetable life, they were considered suitable to be embanked. Various opinions were entertained as to the source of the material forming these accretions. The Author believed that it preceded from the sea face of the coast of Holderness, as it could only come in with the tide, and be deposited at the time of high water. In support of this view, a quotation was made from "The Geology of the Yorkshire Coast," by Professor Phillips; and a Paper "On the Chemical Constitution of the Humber Deposits," by Mr. J. D. Sollitt, read before the British Association in 1853, was also referred to.

In practical operations on the Humber, endeavours were in the first instance made, to secure a thoroughly uniform surface to the land to be enclosed. Thus, a year or two before embanking, the ground was drained by "gripping," so as to let off the whole of the standing pools, and allow the depressions to silt up. The permanent drainage of the land was provided for by a sluice, the size and the level of the cill of which were determined by the rise and fall of the tide, and the extent of land to be drained. With regard to the sectional form and area of the bank itself, where the outer face was exposed to a heavily rolling sea, the slope should be gradual: and if the soil to be used in its construction was light, then the bank must have a wide base, and there should be a puddle wall in the centre, to prevent leakage. If a slip took place in a tidal embankment, fascines or fagots should not be employed, as they were liable to act as conductors for the water.

In illustration of these remarks, the works of the last embankment, for enclosing 700 acres of new accretion, at Sunk Island, were described. They were commenced in April 1850, and were completed in the December following, the tide having been excluded by the 1st of July; and they were executed under the direction of the Author as Engineer, Mr. G. C. Pauling being the Contractor. The total length of embankment was 6,067 yards. That portion which had to encounter the storms of the Humber was 3943 yards in length, its greatest height being 8 feet 10 inches, width at the base 61 feet, and at the top 4 feet. The outer face had a slope of 5 to 1, and the inner of $1\frac{1}{2}$ to 1. The remaining portion of the embankment was 2124 yards in length, had an average height of 6 feet 3 inches, though in one part it was 7 feet 6 inches high, was 32 feet wide at the base, and 3 feet at the top. The outer face had a slope of 3 to 1, and the inner of 1 to 1. In making the embankments, the material removed in forming the drains round the inside of the enclosure was employed; where this was not sufficient, the contractor was permitted to excavate from the foreshore, provided the cutting did not exceed 4 feet 6 inches in depth, and did not approach within 6 feet of the bottom of the outer slope. Channels were cut to allow the water which accumulated in these pits to run off after every tide; and within four years these pits were silted up, by tidal deposit alone. The banks were raised at once to the height of ordinary spring tides, the natural creeks being left open. These were then filled up simultaneously, and the whole of the banks brought to a uniform level, to the full height required. The first bank cost ten shillings and sixpence, and the second four shillings and sixpence per lineal yard; or at the rate of fivepence farthing and fourpence farthing per cubic yard on the average respectively. The banks were perfectly watertight from the first, and the greatest settlement in any part was not more than 15 inches.

Details were then given of the self-acting draining sluice, or clough, which was provided with tidal doors, and had been erected at a cost of £380. It appeared that the foundation consisted of timber piles, and that the superstructure was composed of brickwork with stone copings. The hollow quoins, the framing of the gates, and the top cills were of English oak; the bottom cills being of elm timber. A door, capable of being raised or lowered by machinery, was provided, to admit of the outfall, which was liable to be silted up in dry seasons, being occasionally scoured; and this door could be used, in very dry seasons, for admitting a quantity of tidal water, to fill the fence ditches.

Soon after the exclusion of the tidal water, the marine grasses decayed and fresh water grasses gradually appeared. In about three years, a tolerably good surface of pasture was naturally formed, and on Sunk Island there arose a spontaneous growth of white clover. Some remarks were then made on the value of this land for tillage, and it was stated that the tenants on Sunk Island admitted that they frequently obtained six imperial quarters of grain per acre. Flax was also produced in large quantities and of fine quality; and root crops, as potatoes, turnips, mangold wurzle, &c.

ON RECLAIMING LAND FROM SEAS AND ESTUARIES.

By MR. J. H. MULLER, (OF THE HAGUE).

The Author stated, that he understood works of this class to comprise an area either of salt marsh, samphire ground, slake, mud, or sand, lying more, or less above the level of low water, and being reclaimed from the sea by means of embankments, and drained by natural means through the sea banks. Reclaiming land was frequently looked upon as a hazardous speculation, owing to the probable contingencies where water had to be dealt with, and to the benefits being generally prospective. It was often condemned on account of the state of the ground, which was pronounced to be unsuitable for the purpose. But the question should not be determined in that way; for the value of the ground before being reclaimed was no measure of the merit of the proposal, which could only be decided by comparing the cost of the necessary works, with the improved value that would be given to the land, when that operation had been accomplished.

After contending that the effect of reclaiming, or draining land was to remove the cause of malaria, or ague, and not, as had been erroneously asserted, to produce it, the Author proceeded to point out, that in designing such works, the object should be to enclose the largest area, with the least length of bank, and the smallest average cross section. These points were regulated by the direction of the sea bank, to which attention was next called. It was sometimes recommended that the sea bank should be, as nearly as possible, parallel with the current, and at an angle to the prevailing winds. But experience seemed to show, that, where creeks did not interfere, a different system was preferable; and that one side should be boldly exposed to the full force of the gales, and that the current should be allowed to act upon it almost at right angles, if, at the same time, that one side would shelter, or protect the two other sides. By this arrangement a less extent of bank required supervision during gales, and it also presented advantages during construction. The line of embankment should, if practicable cross creeks at right angles, and at the same level; and in all cases, care must be taken to secure the bottoms of the creeks by aprons, to prevent them from becoming deeper.

The extent of land to be reclaimed at any one time was then considered, and it was argued that large areas were the least expensive in the end; for if a small area was selected at first, some portion of the original sea banks would be useless, when an increase became desirable. If the banks could not be constructed entirely on the salt marsh, it was preferable to go to half-tide level. The difficulty in the construction did not increase with the size of the area reclaimed, but depended upon the openings left in the banks. As instances:—in reclaiming a piece of land of 1000 acres, by a bank three quarters of a mile in length, the seat of which was 6 feet below the level of high water, only one opening 7 chains in width was left. In another case, in reclaiming 1700 acres, by a bank four miles in length, the seat of which was 8 feet below high water, three openings, of 5, 7, and 12 chains in width, were left. In neither case was the speed of the outgoing current materially increased, during the progress of the works, nor indeed until the cross section of the openings was diminished. In completing the latter work, the aprons were raised 18 inches, or 2 feet at a time, by wood work, stone, and clay. It was expected that the current would increase in the third opening, when the two others were raised; but this did not occur, as the water within the enclosure did not reach so high a level as that without; in fact, it never attained to high water mark. When the aprons were above the level of the reclaimed land, the current on leaving became violent. This could not, however, be avoided, in finally closing a bank.

Between the old sea-bank and the edge of low water, [the soil might be divided into four distinct classes:—the salt marsh, of 'clay, about the level of summer spring tides; then samphire ground, slake or mud, or rich alluvial matter, to half tide; next, hard sea sand; and lastly, near low water mark, quicksand. Banks entirely on the salt marsh were the easiest and the strongest that could be made. Those on samphire ground and mud were the most difficult; slips were of constant occurence, the use of waggons and horses was impossible, and a large proportion of the material was washed away as it was deposited, before the bank was consolidated, and raised above high water mark. In fact, for waste, settling, and contingencies, from 60 to 100 per cent. of the original quantity must be calculated upon as necessary. If a storm arose, during the progress of the works, the slopes could not be protected; and indeed a bank constructed on such a bottom was always unsafe. When the line of the embankment was laid at the half-tide level, or about the limit of vegetation, and on hard sand, it was possible to make the whole of the reclaimed land fit for cultivation, and this plan need not cost more, and was safer, than by adopting the higher, but softer bottom. Banks on the lower level were not advisable.

Having stated the conditions to be observed in the direction and situation of the banks, the next question requiring attention was the cross section. This naturally divided itself into two parts:—the main body to resist the dead weight of the water when at rest, and the mode of protecting the slope to enable it to resist the action of the water when in motion. With regard to the first point, the best cross section was that, where the centre of gravity came nearest to the bottom, and to the toe of the bank. For this reason steep slopes with a cess, or bench, about the level of high water, were preferable to flat slopes without a cess, or bench. Sand standing at its natural slope was sufficient to resist still water.

Breaches in banks were attributable either to a small percolation of water underneath the seat, or to the defence, or protection of the slope being insufficient. Frequently, it was not possible to obtain clay in sufficient quantities to form a puddle wall in the centre of the bank; and if the wave was strong enough to break through stone and wood, clay would not be able to resist it. Sometimes, at extraordinary high tides, a breach would occur above the cess, but this rarely happened, and the time during which danger could arise was so short, that the evil might be remedied before next returning high tide. When the water rose above the top of the bank, the back, unprotected slope was liable to be damaged, and thus to lead to a breach. This might be averted by driving stakes into the top of the bank, and placing planks, supported by clay, or other materials, behind them.

With respect to the protection of the slope, there was a difficulty in ascertaining correctly the force of sea-water when violently agitated. Mr. Storm Buysing had stated, in his work on hydraulic engineering, that the shock of the water and of floating objects against slopes, increased in the same ratio as the sine of the angle formed by the slope with the horizon. De la Coudraye and Brémontier contended, in their theory of the motion of waves, that the water only moved vertically up and down, without any horizontal displacement. It was well known, that the sea had the power to destroy banks, and to displace stones of considerable weight; and the engineer must be guided by experience, in dealing with these matters, rather than by speculative opinions.

The materials employed for the defence of slopes were of three different kinds, clay and grass flags, wood and stone. When banks were constructed on salt marshes, the body consisted of clay taken from the adjoining excavations. In this case it was advisable, after trimming the slopes, to sow coarse and meadow grass and clover seeds, and to protect the whole with a crammat. The crammat, which cost threepence or fourpence per square yard, was composed of a layer of clean barley straw, about two inches thick, evenly laid, and fastened to the clay by straw bands, or strands, sixty to ninety stiches being made per superficial yard. In two or three years the bank was so consolidated, that the mat did not require renewal. When these banks were on a lower level than the salt marsh, a protection of clay and grass was insufficient. In such cases, a layer of clay protected by stone, at a slope of 4 or 6 to 1 was employed in England, but without a cess, or bench. This afforded the requisite strength, but it was expensive, and as usually constructed, it needed much repair. The Author thought that, when the bank was constructed on samphire ground, as within a comparatively short period a new salt marsh, or foreshore would be formed it would be sufficient to protect the slope of the bank with wood, and that the slopes above the cess need not be protected, nor be flatter than 3 to 1.

A description was then given of the protection by fascine work. This consisted of layers of fagots, 5 or 6 inches in thickness, placed in a direction up and down the slope of the bank, the thick ends overlapping the thin ends of the lower rows. These were fastened down by stakes, which were left 8 inches above the fagots, and were connected together by means of willow binders, or "wattles,' something like hurdle work. When the proper sort of wood was obtained, this protection would endure from five to seven years, and was quite able to resist the action of the tide. The strength of this kind of protection might be increased, by increasing the number of the stakes and binders, or by filling in with stone, firmly wedged between the rows of stakes. The stone defence, as commonly constructed by the Dutch, on islands exposed to the ocean, was formed thus: when the slope was trimmed, a layer of clay, 12 inches to 18 inches in thickness was spread over it, covered, sometimes, with a crammat. Over this bricks, in one, or two courses, were laid, and then from 6 inches to 12 inches of brickbats, on which stones from 12 inches to 18 inches in depth were set. This work, though very durable, was costly, and hence should only be adopted where security rendered it necessary; as, for instance, for banks near to low water mark. Details were then given of four different cross sections, and it was observed that, with a stone defence, the slopes were recommended to be flatter, and the banks to be higher, than where wood protection was employed; for, it was expected that the former would be built in more exposed situations. In some cases it had been found advantageous to introduce rows of oak stakes, at intervals above the surface of the stone, to break the force of the waves.

In the construction of sea walls, or banks, the most difficult operation was that connected with the crossing of creeks, before alluded to, especially when the bottom was 10 feet, 20 feet, or more under low water mark. In England, the usual plan was to fill in large quantities of material from the sides; but this was a costly method. In Holland, on the contrary, the custom was to raise the bottom uniformly to the level of low water by means of cradles. The cradle was formed of brushwood, bound together by ropes and osiers, and was usually from 2 feet to 3 feet thick. It should be made on a flat sand, or silty ground, about 3 feet below high water, of the full length of the opening, and of proportionate width; being perfectly flexible, it adapted itself to the inequalities of the ground. It was stated, that particular attention must be paid to the stakes, or fastenings, by which it was held down, as the safety of the cradle depended entirely upon them. After being so secured, it was weighted with clay, brickbats, and stones. The mode of constructing a cradle, of floating it to its place, and of sinking it in the centre line of the intended embankment, were then minutely described. The sides of the opening were next protected with similar cradles, the lower end of each resting on that first laid. Subsequently, other cradles were sunk over these, until the work reached low water mark, when the width of the embankment was gradually increased, by throwing in sods on the flood side protected by fascine work, weighted with stone. The same process was then pursued on the ebb side. When the surface of the creek was level with, or above low water, cradles were not required. In such cases, the ground was covered with a thin layer of clay, protected by an apron of fascine work.

In conclusion, the mode of constructing the banks themselves, by side cuttings at least 20 feet from the foot of the slopes, was described; and it was urged that each part undertaken should be raised to its full height in one tide, the exposed side being covered with a thin layer of clay. In the next tide, this should be provisionally protected by a crammat, and before the ensuing spring tide, the work should be finally protected with stone or wood.

THE MALTA AND ALEXANDRIA SUBMARINE TELEGRAPH CABLE.

By Mr. H. C. Forde, M. Inst. C.E.

It appeared that, in May 1859, Her Majesty's Government determined, that a telegraph cable should be laid between Falmouth and Gibraltar, and the late Mr. Lionel Gisborne and the Author were appointed joint engineers. Subsequently, and after some progress had been made with the construction of the core and the outer covering, it was proposed to use the cable to join Rangoon and Singapore. This idea was, however, abandoned, and, in January 1861, it was decided that it should be laid between Malta and Alexandria, an operation which was carried out in the summer of that year, the communication having been successfully completed on the 28th October, 1861.

The recommendations of the late Mr. R. Stephenson and Sir Charles Bright, as to the form and size of the cable to be used between Falmouth and Gibraltar, were then referred to; and it was stated that iron covered cables of three sizes were designed for the varying depths up to 600 fathoms, and for the greater depths, across the Bay of Biscay, a cable covered with twelve steel wires, each enveloped in a hempen strand, laid in a spiral form. The latter was abandoned when the destination of the cable was changed; but the other forms of outer covering were retained, as considerable progress had been made with their manufacture. If it had been known at first, that the cable would be laid in comparatively shallow water, a different design would have been adopted. The outer wires were much larger than those of the Atlantic, the Red Sea, and the other Mediterranean cables containing a single conductor, and the conductor was nearly four times the size of the Atlantic cable, and twice that of the Red Sea Sea cable.

The contract for the manufacture of the core was intrusted to the Gutta Percha Company; the contracts for the outer covering, and for laying and maintaining the cable for thirty days after completion, were let to Messrs. Glass, Elliot, and Co. The conditions of the contracts were then given in detail, the main features being that the core and the cable were to be kept continually under water, during the manufacture and the laying, and that the electrical tests were to extend from the commencement of the manufacture until thirty days after submersion of the whole line. The different processes involved were next described, and it was stated, that under a pressure of from 600 lbs. to 800 lbs., the electrical condition of the core improved about 10 per cent. The relative resistance per knot, both as to conduction and insulation, of the Atlantic, the Red Sea, and the Malta-Alexandria Cables, was represented by the numbers 1, 4, and 37. It was requisite that great care should be observed in making the joints of the core, of which they were four thousand two hundred in the Malta-Alexandria line, as the slightest imperfection in any one would be attended with danger.

A difficulty having arisen in keeping the cable permanently under water, one portion became exposed to the air, and was allowed to dry. When tested a loss of insulation with increased resistance in the conductor was observed. An investigation by Dr. W. A. Miller, F.R.S., showed, that this deterioration was due to heating, from the effects of oxidation. It was consequently resolved that the original idea of fitting the two ships with water-tight tanks should be carried out. The way in which this was accomplished, and the manner of coiling the cable on board were then alluded to. The eye of each coil was fitted with an open framework of timber, by which arrangement a fault was cut out of the centre of a large coil, without its being necessary to uncoil the whole cable, as would have been the case with a solid eye.

Previous to commencing the operation of laying, the route was most carefully surveyed by ships of the Royal Navy, when it was ascertained that the Admiralty charts were in parts incorrect in latitude, and were deceptive as to the soundings, the general depth and the conformation of the sea bottom being very different to what they were represented to be on the official charts.

Each ship was fitted in the following manner: A large V sheave, furnished with a small friction band, was suspended above the centre of the hold, and over this the cable was led. The paying-out apparatus, placed on one side of the stern, consisted of three V sheaves, in one vertical plane, and parallel to the centre line of the vessel, each sheave being provided with a friction strap. The cable was passed over these sheaves under three weighted jockey pullies, to the brake drum, round which it took three or four turns; then over a fixed sheave, and under a moveable weighted pulley, into the sea over a fixed stern-wheel at the level of the last sheave. The dynamometer employed was similar to that used on the occasion of the successful laying of the Atlantic cable.

This first portion of this line was laid between Malta and Tripoli, the greatest depth being 420 fathoms. The cable was paid out at an average rate of 4·94 knots per hour. The maximum strain to which the heavy shore-end was subjected was 20 cwt., but with the main cable this did not exceed 12 cwt. The estimated slack paid out in the deep water was not quite 5 per cent. No difficulties of any kind occurred, until attempts were made to splice the main cable to the Tripoli shore-end, which had been laid by another ship. Nine unsuccessful attempts were made, owing to bubbles forming under the fresh gutta percha, but by cutting off a length of 25 fathoms of the shore-end, a perfect junction was effected. The remaining cable on board this ship was laid in the direction of Benghazi, the maximum depth attained being 150 fathoms, the average speed of paying out 5·3 knots per hour, and the greatest strain 9 cwt. The cable next laid was part of the third section, commencing at Alexandria, and extending nearly 300 miles to the westward, towards Benghazi. The roughness and irregularity of the bottom rendered this operation very critical; but by carefully selecting and laying out the route to be pursued, after accurate soundings had been made, and by only paying out in daylight, it was successfully completed. Six days were occupied in laying 128·8 knots of heavy cable and 153·32 knots of main cable, or a total length of 282·12 knots. Thirty-two buoys were laid down to mark the route, and upwards of sixty different courses were run. The maximum depth of water was 102 fathoms, the minimum, for a short length, was 13 fathoms, and the average 33 fathoms. Subsequently, the second part of the third section between Alexandria and Benghazi, and the second part of the second section between Benghazi and Tripoli were laid, and the communication was established. No accurate estimate could be made of the actual slack paid out, but as a general rule in depths under 100 fathoms, from 2 to 2½ per cent. was the utmost that could be got out of the ship when the cable was running quite free. The angle at which the cable was paid out ranged from 40° to 45°. The maximum speed was 7·15 knots, the minimum 4·5 knots, and the mean 5·25 knots per hour.

Respecting the tests during and after the laying, it was observed that as the cable was paid out, its electrical condition invariably improved; the highest resistance being found in the deepest and coldest water, and the lowest in the shallowest and warmest water. Experiments as to the rate of working showed, that the speed attained agreed very nearly with that which had been anticipated, namely, five words per minute through a length of 1100 knots, except through the short sections, where the limit of the speed depended simply upon the skill of the clerk.

The communication was accompanied by a map, showing the general course of the cable, by a longitudinal section of the sea bottom, and by diagrams of the electrical tests. Specimens of different cables were also exhibited.

ON THE ELECTRICAL TESTS EMPLOYED DURING THE CONSTRUCTION OF THE MALTA AND ALEXANDRIA TELEGRAPH, AND ON INSULATING AND PROTECTING SUBMARINE CABLES.

By Mr. C. W. Siemens, M. Inst. C.E.

Having been employed by Her Majesty's Government as the Electrician superintend the manufacture and shipment of the Malta and Alexandria Telegraph Cable, the Author was in a position to speak as to its actual state of insulation, at different stages of its progress, and as to its general superiority compared with former lines. The methods of testing differed essentially from those previously resorted to. This was the first line that had been tested systematically throughout; and the importance of a uniform and well-devised system of electrical tests being carried on during the manufacture, shipment, laying, and subsequent working of submarine cables, had been fully proved.

The covered strand of conducting wire, in lengths of one nautical mile, was placed for twenty-four hours in tanks filled with water maintained at 75° Fahrenheit. It was afterwards removed into a pressure tank, containing water at the same temperature, and when uniformly heated, it was tested for conductivity and insulation, and the result, expressed in units of resistance, noted. A pressure of 600 lbs. per square inch was then applied, and the electrical tests were repeated. Before any coil was approved, it was required that the copper resistance should not exceed 3·5 (Siemens) units, or possess 80 per cent. of the conductivity of chemically pure copper; that the gutta percha resistance per knot at 75° should amount, at least, to 90 millions units, corresponding to about 80 per cent. of the highest insulation that could be obtained with the best gutta percha of commerce; and further, that the insulation should improve when the pressure was applied, which was invariably the case when the covering was sound. The coils were then transferred to Messrs. Glass, Elliot, and Co.'s works at Greenwich, where they were submerged in tanks until required for the sheathing machine. The sheathed cable was coiled into large tanks, and was always intended to be covered with water, but owing to a defect in the construction of the tanks, this regulation could only be partially carried into effect. It was also intended, in the first instance, that the ships should be provided with water-tight tanks to receive the cable during the outward voyage; but owing to the passive resistance with which every deviation from previous routine was usually met, this plan was not carried out, until the heating of the cable on board the S.S. 'Queen Victoria' had proved, at great cost, that tanks were essentially necessary. There were other important advantages obtained through the adoption of the water tanks by which the causes of failure in paying out were avoided, and the operation was rendered comparatively safe and easy.

In conducting the electrical tests of the Malta and Alexandria cable in the course of its manufacture, the chief object was to obtain throughout strictly comparative results. For this purpose it was necessary to adopt a standard measure of resistance, by which to express both the conductivity of the copper conductor and of the insulating covering. This standard measure had been supplied by Dr. Werner Siemens. The unit of resistance was that of a column of pure mercury, contained in a glass tube, one metre in length between the contact cups, and of one square millimetre sectional area, taken at the temperature of melting ice. As the testing apparatus had been already described in the Blue Book "On the Construction of Submarine Cables," it was not necessary to repeat it. In the Appendix to this Paper, tables were given of the results of observations upon two sections of the cable, at various stages of their progress, between Malta and Tripoli, and between Tripoli and Benghazi; and diagrams were exhibited representing graphically these results. On comparing the insulation of the cables after being laid down, with the insulation observed shortly before on board ship, there was a decided improvement after submersion. This was partly due to the pressure upon the cables, the insulation improving 2 per cent. on an average for every 100 lbs. of pressure upon the square inch, and partly to the lower temperature at the bottom of the sea.

Respecting the construction of a cable of a more permanent character than any hitherto made, to which the Author had given much consideration for many years, it was observed that with regard to the insulating covering, nature seemed to have provided only two suitable substances, india rubber and gutta percha, combining permanent pliability at all ordinary temperatures, with high insulating property. India rubber had a higher insulating power, a lower specific induction, and was capable of resisting higher temperatures than gutta percha; but the latter could be put upon the wire in a plastic state by a dye process, and gave greater security against faults than the lapped india rubber covering. It was also less liable to receive accidental injuries, to become sticky or semi-fluid when exposed to the atmosphere, and resisted the action of water more perfectly.

The absorption of water by gutta percha, india rubber, and compounds of india rubber, such as vulcanised india rubber, Wray's mixture, and a compound with mica, under various pressures and temperatures, and from water containing different degrees of salt in solution, had been fully investigated. These experiments served to show, that an increase of pressure up to 50 lbs. per square inch, did not increase the rate of absorption, which was found to be more rapid from pure water than from sea water, and from sea water than from brine. Raw and unvulcanised india rubber absorbed water in greater quantities than the other materials; while, next to gutta percha, vulcanised india rubber showed, both in fresh and salt water, the greatest insensibility to absorption.

The results of experiments on the insulating and inductive capacities of wires coated with india rubber, in combination with gutta percha, compared with those of special gutta percha and pure india rubber at different temperatures, were then given. The lengths experimented upon varied from 600 to 2500 yards. The specific resistance of special gutta percha decreased from 9·11 at 50° Fahrenheit to 1·50 at 80° Fahrenheit, or to be about one-sixth of its original value; while the combination of india rubber and gutta percha had, under the same circumstances, only gone down to about one-third of its insulation at 50° Fahrenheit. The inductive capacity of the combined india rubber and gutta percha wire, and of pure india rubber covered wire, was as 0·7 to 1. Notwithstanding the comparatively high insulating property of india rubber, its low inductive capacity, and its power to resist heat, its gradual dissolution in sea water was a circumstance which alone rendered it inadmissible for submarine wires, unless it was securely enclosed in another waterproof medium, and gutta percha appeared, in every respect, well suited for such outer covering. It was desirable, that the india rubber should be brought upon the wire without the application of heat, or solvents, both of which often entailed a gradual decomposition of that material, particularly when exposed to atmospheric influence in contact with copper. Dr. W. A. Miller had stated, that the liquefaction was the result of a process of oxidation, from which it might be inferred, that the effect could not take place where oxygen was excluded. It, moreover, was important to produce a perfectly cylindrical covering, and taking advantage of a peculiar property of india rubber cohering perfectly where two fresh cut surfaces were brought together under considerable pressure, the Author had constructed a covering machine which fulfilled the several purposes. Such combined india rubber and gutta percha covered wires had been tried under various circumstances, exposed to the atmosphere, to water or the moisture of the ground, for nearly two years without betraying any signs of gradual deterioration of the india rubber, or the appearance of faults. A circumstance greatly in favour of the bi-covered wire, was that the gutta percha shrank upon the india rubber covered wire, and when any mechanical injury to the covering occured, the yielding india rubber was forced into the gap, by the elastic pressure exercised by the gutta percha, and prevented the appearance of a fault.

The outer covering of cables, as hitherto constructed, was certainly the least perfect part. An iron sheathing was very necessary to protect the insulated core in shallow waters, but for cables in more than 30 or 40 fathoms of water, the iron sheathing was an element rather of weakness than of strength. It rendered the cable ponderous, its shipment expensive, the paying-out risky, and repairs impossible, owing to the difficulty of raising a heavy cable from a great depth under any circumstances, and the absolute impossibility of doing so after corrosion of the iron wire had made some progress.

When the Falmouth and Gibraltar cable was first contemplated, the Author, in conjunction with Mr. Forde, proposed to cover each iron wire with gutta percha, with a view to prevent oxidation; but the system was not acted upon, except by way of experiment. Mere protection of the wire was, however, not sufficient, in the Author's opinion. It was capable of mathematical demonstration, that in paying out a wire sheathed cable, with a considerable strain upon the break-wheel, it would untwist while in suspension in the water, to a considerable extent, causing elongation of the core to the amount of say one per cent., or even more. On reaching the bottom, the strain and consequent twist would be released. Copper wire could not be elongated more than 2 per cent. without receiving a permanent set; and it was also a well ascertained fact, that when telegraph core had been stretched at any time beyond the limits of elasticity of the copper, the latter being henceforth too long for the more elastic covering, would tend to assume a serpentine form, and to push its way through the insulating material by slow degrees, particularly in places when short bends or kinks occurred.

Based upon these views, the Author designed a sheathing of the following description:—The insulated conductor, or core, was passed in the sheathing works through a series of three machines in close succession. In passing through the hollow spindle of the first machine, a close spiral covering of hemp, previously saturated in Stockholm tar, was applied in such a way, that each string was and remained under a given strain. The second machine was similar in construction to the first, but supplied a second covering of hemp wound in the opposite direction to the first. The rope thus formed, passed next through a stationary clip, with longitudinal grooves to prevent it from turning round in the operation immediately following, which consisted in the application under the influence of great pressure, of from three to six strips of copper, or other metal, which might best resist the action of sea water. These strips were accurately guided into the revolving covering tool, so as to overlap each other equally for nearly half their breadth, the pressure applied being sufficient to crush, or socket the one metal down where it was covered by the other. This cable had no tendency to untwist; its extension with half the breaking strain upon it did not exceed one-half per cent., and being very strong, and of only double the weight of water it would support about 8 miles of its own weight in the sea.

Considering that good ship's sheathing lasted about 10 years, when the ship was at rest, and that the cable had two layers of metal, with hardened tar between, it appeared not unreasonable to suppose, that this sheathing would last at the tranquil bottom of the ocean from 20 to 30 years at least. Several short lengths of this cable were now being tried, under various circumstances, and the results, so far, were promising of success upon a larger scale.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

Mr. Francis Campin in the Chair.

ON STEAM BOILER EXPLOSIONS.

By Mr. Charles B. King, M.E.

The Author commenced by stating that a more perfect knowledge of the laws of heat, had enabled modern engineers to calculate with tolerable accuracy, the probabilities of steam boiler explosions, and though from mismanagement or undiscovered causes, these catastrophes may never wholly cease, still science may, and ought, to throw as much light as possible on the subject; and by comprehending throughly the causes, avoid the effects.

The generally received idea of the cause of explosion, viz., excessive internal pressure, is certainly open to grave objections.

Instances have occurred, where explosions of boilers have taken place, on the engine being set to work after an interval of rest, this appears on the face of it, mysterious; a boiler being relieved from steam, should be followed by an increase, such increase, causing a violent rupture of the fabric. It is evident a theory of excessive internal pressure will not hold good in these cases. Some writers, in explanation of this anomaly, have ingeniously supposed, that upon the opening of the valve, an undue agitation of the water is produced, by which it is dashed against the hotter portion of the furnace plates, and more particularly, should any part of it have been left uncovered, through a deficiency in the supply of feed water, resulting in a largely increased quantity of steam and a corresponding increase of pressure.

So here, explosion might be attributed to an under charge of water, if we did not know that an overcharged boiler has frequently exploded, and it is contrary to mechanical logic, to ascribe a maximum of the effect from a minimum of power.

Still, there does seem ground for the supposition of some violent internal action, at the instant preceding the actual rupture; the rupture being regarded as the consequence of such action, and not a mere pressure, which, until the ruptured parts are in motion, can only act statically.

This hypothesis has derived a certain probability from frequent instances of the quick rupture of steam boilers.

The first abstract cause of explosion that obviously suggests itself, is overheating.

Now, though boilers may be exploded by the formation of a great quantity of steam, from water dashed on red hot plates, yet overheating is not the general cause of explosions. There have been explosions, where the water gauges only a moment, before indicated a full supply of water, and in such cases the furnace plates have been found in a perfectly sound condition, and not at all burnt.

It is also doubtful, whether the pressure already in the boiler would be greatly increased by the quantity of steam disengaged, supposing extensive overheating to have taken place, and water to be suddenly thrown on the heated plates.

According to the best authorities, the quantity of heat that would be required to raise the temperature of 112 lbs. of iron, would impart the same temperature to only 12 lbs. of water. This deduction from the accepted laws of heat, is borne out experimentally by plunging any weight of highly heated metal, into an equal weight of cold water.

It is a favorite opinion of many engineers, that the presence of highly heated steam in a boiler, is sufficient of itself, to account for the most violent explosion. This, however, is incapable of proof, although any one can blow up a boiler, no one can definitely prove that the superheated steam, decomposed steam, or electricity is the active cause.

A most cursory glance at the properties of steam, as elaborately defined in Professor Miller's work on chemistry, will show that the hypothesis is decidedly erroneous. It is evident no heat can be generated within the steam or water chambers of a boiler. All the heat that may exist then, must have been externally communicated, i.e., from the fuel of the furnace. Heat acts by its quantity, the same as ponderable matter, and in its effect is quite as measurable as a solid body.

The quantity of heat which will raise a pound of water to the temperature of one degree, is as indefinite and invariable as the quantity of water which will fill a given space, or as the weight of the air we breath. Steam superheated, cannot lose any part of its heat without being more or less condensed.

The Author then touched on electricity as a cause of boiler explosions, and showed from various experiments and other causes, the inferences which would be derived, ending mosily in obscurity and mystery.

With regard to over pressure as a cause of explosion, the author said that the pressure in a boiler, must be comparatively gradual, and if over pressure were a sole cause of explosion, they would of course rupture in the weakest part. Care ought, therefore, to be taken that the materials used be of a kind capable of resisting pressure. For this matter, a knowledge of metallurgy is decidedly useful to discriminate between the varied species of metals and their peculiar fitness for certain specific uses.

Even, when excellent material has been used, it is subject, of course, to the same casualties as inferior materials.

Corrosion, which frequently goes on unexpected, will render the most admirably constructed boiler dangerous. Thus, we find that an explosion of a boiler, at Clyde Grain Mills, at Glasgow (in 1856), extensive breadths of iron were said to be reduced to the thickness of a sixpence. In the same year, at an explosion, which took place at Messrs. Warburton and Holkirs, at Bury, the bottom plates had been reduced to $\frac{1}{16}$ inch in thickness. It may be reasonably inferred from instances, too numerous to quote, that it is extremely probable, that explosions occur at nearly the ordinary working pressure, and that such explosions would not have occurred, had the boiler not contained some hidden defect.

Supposing, however, that well constructed boilers, both as regards workmanship and material, have burst by over-pressure, it is by no means difficult to suggest a remedy. If one or two safety valves are sufficient under ordinary circumstances, to liberate steam as fast as it is generated in the boiler, an addition of others working independently of each other, would effectually prevent all chance of over-pressure, for whilst it is quite possible for a boiler unprovided with safety valves, or with such as are inoperative to produce an explosion by over pressure; it would be equally impossible to do so when these outlets from the boiler were equal in discharging capacity to its evaporating powers. The fact of explosion by over pressure, therefore, is a proof simply that the safety valves were either inoperative, or of insufficient size.

Having now endeavoured to set before you the cause of boiler explosions, and investigated how far they are admissible, it only remains for me briefly to sum up the argument by a few practical observations.

The synopsis of our argument you will observe to be as to the occurrence of rupture without explosion. I have seen and known of many, and they are well known to others. As to their occurrence above the water line, the escape of the free steam is easily enough understood, and is furthermore calculable that the steam in the water, or the steam ready to form in the water, must rush to fill the void is equally clear, although as the resistance to the rise of the steam in the water is to some extent greater than that to the escape of the free steam through the already opened rent; the rising steam and water will have hardly had time to gain headway, until nearly all the free steam above the water has escaped. Thus the rising volley of steam and water will have free scope.

The impact on striking is to some extent inferential. We know that a leaden bullet is flattened when fired from a gun into water. Therefore if water moving at the same velocity as a bullet should strike a plate of iron at rest, the concussion would be the same as with the gun. Jacob Perkins was enabled to project leaden bullets $10\frac{1}{2}$ times heavier than their own bulk of water, with steam of 900 lbs., and even 500 lbs. to the inch, and with a force and velocity equal to that of bullets fired in the ordinary manner. In the case of a boiler during the moment when the water is rising in the act of explosion, we may consider that the urging pressure is almost all below the water; i.e., that there is little pressure above it. It is evident then that the water must rise with great violence.

I think that engine drivers and stokers are in some instances the cause of boiler explosions; they rarely possess anything more than the ability to perform their duties in a most automaton-like manner. Some may say that this is all that may be required. If a man knows that when he turns a cock on the water will run, and when he turns it off it will stop, he will be a very good engine driver. Results prove the contrary, between two men, one performing his duty mechanically, the other systematically and rationally, you will find the latter will do it best.

If the former deviates from the beaten track he knows not how to remedy his *faux pas*. The mind of the latter comes to his aid and extricates him.

It is therefore a matter of reasonable enquiry whether in these days of increasing enlightenment those who have such a responsible office as that of conducting a locomotive, on whose safe regulation depends the lives and safety of numbers of their fellow citizens, should not be better instructed in the scientific details of their duty, that they should be able from their own reason and common sense to avoid the dangers they now only see in a hazy vague mist, and of whose cause they are wholly ignorant, and can produce only the reason, it is because it is. I do not design sweepingly to set down the bulk of engine drivers as ignorant and illiterate, but from considerable experience I have come to the conclusion that there are too many such, and events have shown that their ignorance has too often resulted in disastrous consequences. It may seem a very common place observation, that engine drivers in their ignorance risk the most horrible consequences, which, a little knowledge of mechanical science would enable them to foresee and calculate. An experienced engine driver would be able by the aid of science, to ascertain whether the boiler he purposed to govern was in all its parts capable of its functions. No later than March 6th, a verdict of manslaughter was returned against an engine driver, whose neglect had caused an explosion at Dudley in which 6 persons were killed.

One word on the material used in constructing boilers. It is well known that when an engineer receives an order, he tries either to add to his reputation by the excellence of its fulfilment, or he tries to get as much money out of it as possible. It will be found that the passion for gain is the main cause of half the miseries of life; I believe it to be of boiler explosions.

I can conceive nothing baser than a man, who, to get a few pounds extra in the fabrication of a boiler, uses such materials as he knows must speedily wear out, and risk the destruction of his fellow men, merely because it is cheaper.

I admit that many may, and doubtless do use bad material from inability to judge of its merits. But this surely ought not to be the case with any one desirous of excelling in his profession.

The connecting link between all sciences, as relatively dependent in some degree on one another is clearly seen in the intimate relations between geology, mineralogy, and engineering; a very little investigation will suffice to give the student a sufficient knowledge of these very interesting sciences, which will be found, in instances too numerous to mention, most important adjuncts to mechanical science.

In the foregoing remarks it would be seen, I have adopted in a great measnre the reasoning of Mr. Colburn, whose excellent treatise on this subject should be carefully read by all interested in this subject, and I must here tender my thanks to that gentleman, and also to Mr Charles Wye Williams, for very important hints and suggestions connected with steam boiler explosions.

REVIEWS AND NOTICES OF NEW BOOKS.

Researches on the Danube and the Adriatic; or, Contributions to the Modern History of Hungary and Transylvania, Dalmatia, Crotia, Servia, and Bulgaria. By A. A. PATON, F.R.G.S. 2 vols. London, 1862: Trubner and Co., Paternoster Row.

The attention which is now being directed to Turkey, and things Turkish—and seeing too that the Danube will henceforth take the place of the Rhine, Switzerland, &c., as the *grand tour* for the fashionable travelling English—will give Mr. Paton's work increased interest.

Mr. Paton has condensed into two neat volumes (together upwards of 800 pp.) a vast deal that is exceedingly useful and interesting, and being written in a pleasant conversational style, makes the historical and scientific portions of his work agreeable and very readable.

Hungary and Servia, those beautiful and interesting countries, of which so little is known to but very few of even the best travelled Englishmen, are admirably described, and every-day life excellently pictured.

With Mr. Paton's book, and a but very slight knowledge of French and German, and a vocabulary of Turkish words in common use, the English traveller may, with facility, travel (as from personal experience we can testify) through those delightful countries, and in perfect safety, *sans* revolvers or any other weapons, amongst peoples at once primitive, inoffensive, and hospitable.

As by the existing system of railways through France and Germany, Hungary, Servia, and the lower Danube—by way of Vienna and Pesth—is only about a four days' journey from London, and the Danube is at present navigated throughout its entire length, by steamers (which, for elegance, comfort and convenience, are only to be compared to the best American floating hotels on the Western rivers), and as the extent, continuity, and variety of magnificent scenery is perhaps unequalled, the journey from Paris to Vienna, and down the Danube to Basiash, down the lower Danube through the Iron Gates, and back through Servia and Turkey in Europe, returning up the river Save, by way of Sissek, to Trieste or Fiume, and thence through Italy home, will we prognosticate, be something like the future itineray of a Vacation Tour.

And we think Mr. Paton's book, and the fact of the establishment of an English Steam Boat Service on the Danube, will naturally help in promoting a knowledge of those countries amongst English Travellers, more especially as the expense for travelling. and the cost of living in those countries, is infinitely less than in the hackneyed routes which have hitherto been the favourite and fashionable resort of the English *voyageur*.

Cotton Cultivation in its various Details. The Barrage of Great Rivers, and instructions for irrigating, embanking, draining and tilling Land in Tropical and other Countries possessing high Thermometic Temperatures, especially adapted for Improvements of the cultural Soils of India. By JOSEPH GIBBS, Mem. Inst. C.E. London, 1862, E. and F. N. Spon, Bucklersbury.

We received this book too late in the month to admit of our doing more than briefly noticing its publication, and stating the general impression we have formed of its merits from a hasty perusal.

The great importance which attaches to the extension of cotton production, and the opening up of new fields and sources of supply, gives increased value at the present time to a work, which possesses so much merit, containing, as it does, the largest amount of valuable practical, and scientific information upon the subjects which it treats—which has hitherto been brought together.

Mr. Joseph Gibbs is so well known amongst engineers and scientific men, that his book needs only to be announced to ensure its being in the hands of every one interested in the subject of cotton cultivation (and who at the present time is not?) as also those to whom the systematic and economic irrigation of lands is a matter of study. Mr. Gibbs' book is an admirable work, most opportunely produced.

Help to Memory in Learning Turkish. By HYDE CLARK, *LL.D.* Constantinople, Kœhler, and Co., Smyrna, Castlellan, London, R. Quarich, 1862.

Although the present work consists of only eight pages of Turkish Words, in common use, and their English meaning, it will be found of the greatest possible service to those who may be brought in business relations with the Turks. Dr. Hyde Clarke has, therefore, very opportunely supplied a want which is much felt (as we can personally testify from a recent journey through Turkey in Europe), and seeing that it is almost a hopeless task to attempt to master thoroughly, in a reasonable time, the Turkish language through the existing grammars and vocabularies of Redhouse, Malhouf, Villont, and others.

NOTICES TO CORRESPONDENTS.

J. J. B.—We have been compelled at the moment of going to press, to omit giving your interesting paper until our next issue.

T. S.—Received and used with thanks.

S. H.—(Bolton.)—Thanks. Your suggestion has been anticipated by us; we had already decided to give the paper referred to, but our arrangements will not permit of its insertion in our issue of this month.

W.S.—(Dublin.)—You will find Nystrom's *Pocket Book of Mechanics* admirably suited for the purpose. *See page* 248.

B.B.—Your communication to hand, but not received by us in time to be answered in detail; suffice to say for the present, in answer to your first query, that the formula to which you refer is that given by Mr. Atherton, in a paper which you will find in the ARTIZAN, Vol. for 1861, pp. 233-237.

G.L.—We are obliged to you; you will observe we have rectified the mistake.

G.S.—Sketches to hand, and we must now ask you to send us at your convenience, full particulars in writing, as to the site of the bridge, its capabilities for traffic; send us, in fact, a short history of the affair, which we will then compare with the sketches we have, and will then write to you.

X.—Your enquiry as to the performance of the *Great Eastern*, you will find answered by the abstracts of her logs, given in the present number of The Artizan.

A. D. W.—Consult the standard works of Mosely, and Hodgkinson, and the more recent works of Dr. Rankine and Latham. We should, however, first commend to your study the various papers which have, from time to time, appeared in the Artizan, we would mention more especially those given in the Artizan, Vol. 1861 (and which are continued in the numbers for the present year), under the head of "Practical Papers for Practical Men." These latter, we believe, you will find to answer every purpose you require.

Erratum.—We hasten to rectify an error which appeared in the Artizan of June, in which we inadvertently stated Waddell's patent slide valves had been fitted to the engines of the *Persia*. The valves alluded to were fitted to the engines of the *Scotia*.

We are prevented giving the answers to several others of our Correspondents' letters and inquir ies until next month.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Queen v. Train and Others.—The Kennington Tramway.—In this case Mr. Train and the vestrymen of Lambeth, who sanctioned his laying down a tramway from Westminster-bridge to Kennington-park, was indicted by Mr. Worronzow Greig at the last assizes, at Kingston, and found guilty of having erected an obstruction to the highway amounting to a nuisance, the liability of the vestrymen being left for the consideration of the full Court. Since then the case has been several times before the Court in various forms, which ultimately resulted in the prosecutor, under the authority of the Court, entering a *nolle prosequi* as to the vestrymen, and calling Mr. Train up for judgement.—On this occasion Mr. Train appeared on the floor of the court.—Mr. Montagu Chambers, Q.C., on the part of the prosecutor, prayed judgment.—Mr. Lush, Q.C., made some remarks, in mitigation. The senior puisne judge delivered judgement, and after having reviewed the nature of the proceedings and the nuisance complained of, and which the jury by the verdict had found to be a nuisance, said the Court were bound to give effect to that verdict. The judgment of the Court was that a writ of abatement issue to the sheriff, and that the defendant pay a fine of £500 to the Queen. Mr. Train, upon hearing the judgement of the Court, said he could not pay the fine, and protested in the name of a foreigner, that he had been sentenced without a trial. He was entitled to a mixed jury which he had not been allowed, and not one witness had been called in his defence. It is proper to explain that the effect of the judgment is that in the event of Mr. Train not removing the tramway within a fortnight, the prosecutor can lodge the writ of abatement with the Sheriff of Surrey, who by his offices will be compelled to pull up and remove the tramway, the expenses of which will have to be, on petition to the Crown, remitted out of the penalty, in the event of such a course being rendered necessary.

Bruff v. Conybeare.—The court gave judgement in this case, which was a question whether the defendant, an engineer, was liable upon a contract to pay £300., the first portion of £600., which he had undertaken to pay the plaintiff upon a certain event, namely, that he should be retained as engineer for the transforming of the Chard and Thornton Canal into a line of railway. The canal, however, passed into the hands of the Bristol Railway Company, and they carried out the line of railway in question under the direction of their own engineer. The defendant, therefore, considered himself exonerated from all liability to the plaintiff under the circumstances, and as he refused to pay the said instalment of £300. the plaintiff brought his action, and the jury found a verdict for him for the amount claimed. Subsequently, a rule was obtained by the defendant to set the verdict aside and enter a nonsuit; and in the arguments before the court the question raised was, whether or not the defendant was liable under the terms of the contract. The court, in giving judgment to-day, held that he was not. Rule absolute for a nonsuit granted.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention Chemistry as applied to the Industrial Arts (for which we are chiefly indebted to the *Chemical News*), Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi, London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

Lifeboats in France.—The Emperor of the French has nominated a commission, consisting of the Ministers of Marine and Finance, and the Engineer-in-Chief, to organise a complete system of lifeboats on the French coast similar to that so efficiently in operation on the English coast, chiefly under the control of the National Lifeboat Institution. France has a seaboard of nearly 900 miles. Hitherto the means of saving life from shipwreck has been lamentably deficient. Some engineers are on the French coast gathering every information they can on this important subject.

Discovery of a Tunnel in Liverpool.—While examining an old drain in James's-street, an old tunnel has been found cut in the solid rock, with a pretty-regularly formed roadway at the bottom, and a well-cut channel along its south side to keep it dry. The sides of the tunnel are carefully dressed. Opposite the North and South Wales Bank it is 22ft. deep, from the surface of the street to the bottom, 7ft. wide, and 9ft. high, and retains these dimensions for about 80 yards westward. Opposite the bank, which is probably the point of junction of the tunnel with the old castle ditch, provision for a gate is apparently made. At the end of 80 yards the dimensions of the tunnel diminish to 5ft. wide, and about 6½ft. high.

Pressure of Water.—M. Guibal, professor at the School of Mines at Mons, has recently applied very successfully the compression of water to the detaching of rocks from their beds, and especially to the extraction of coal. At a recent meeting of the society formed by the old pupils of that school, he produced a cast iron cylinder, divided in two by a partition, paralled to its axis, and presenting the appearance of the shaft of a mine. By the application of the pressure of water, he then broke the two cast-iron hoops which bound the two parts of the cylinders together, and the transverse sections of which presented a surface of 100 square millimetres. By calculation it was found that the pressure applied was equal to 75 atmospheres, a pressure quite sufficient to detach coal, but far within the limits which might, if necessary be obtained.

Hunter's Stone Planing and Squaring Machine.—This patented machine has been set to work in the Messrs. Munro's foundry, Dickfield-street, Arbroath; and parties of master builders, quarriers, and others, were present to witness the capabilities of the machine. The stones dressed in their presence were one from the quarry of Rosemill, extremely hard and tough, and abounding in yelks, notwithstanding which the machine did its work in a perfect manner, although it tried its mettle, at about 4in. per minute. The other stones were of a softer caste, from Glasgow, Edinburgh, and the Brax quarries, and were neatly dressed, the Glasgow stone more especially so, at about 6in. per minute. The machine is wholly self-acting, and the gouge chisels are about 6in. in length, of the best cast steel. The machine altogether occupies about 15ft. by 12ft. of space. During the operations, a beautiful specimen of ridge-stone dressing was exhibited, the production of a machine likewise held under patent by the same gentleman. The stones dressed by the machine more immediately under notice were all of ashlar work; but it was stated that the machine could dress hanging steps with bottle and fillet mouldings, and back filleted rivets and corners, &c. The machine and engine are portable, so as to be easily removed from one job to another; and masons will soon become as handloom weavers and hecklers now are, by the introduction of steam and mechanical power. After the trial of the machine was over, the master builders of Dundee, who were present, met together, and were so highly pleased with its performance, that they unanimously resolved to form a joint-stock company, for the purpose of purchasing at least one machine to be used by the Dundee builders.

Prevention of Rotting in Wood.—Take 50 parts of resin, 40 parts of finely powdered chalk, 300 parts or less of fine white sharp sand, 4 parts of linseed oil, 1 part of sulphuric acid, and 1 part of native oxide of copper. First heat the resin, chalk, sand, and oil, in an iron boiler; then add the oxide, and with care the acid; stir the composition carefully, and apply the coating while hot.

Rolling Iron.—In order to produce a finished plate or bar of great size in less time than usual, and whilst the metal is nearer a welding heat, Mr. John Napier, of Glasgow, proposes to arrange two or more pairs of rolls at suitable distances apart, so that the pile of metal to be operated upon may pass onward through any requisite numbers of pairs of rolls placed in succession, and all in about the same direction, the first pair being like the ordinary roughing rolls, and the last pair suitable for bringing the plate down to the finished size. Each of the different pairs of rolls are driven by distinct engines, each being separately governed or regulated to give the required speed, so that in the process of rolling the plate, bar, &c., may be passing through one, two, or more pairs of rolls at the same time, the speed of each pair of rolls being such as is necessary to compensate for the extension or elongation of the plate as it passes from one pair of rolls to another. Instead of using separate steam-engines to each pair of rolls, gearing, and conical drums and belts for varying the speed, may be used. To allow as much as possible scoriæ or gases that may be lodged in the heart of the mass to escape, he makes the centre of the first pair of rolls of larger diameter than the ends, the second pair of similar form, but with less difference between the centre and the ends, and so on reducing the difference until the last pair of rolls turns out the finished plate of the required size and shape. By this arrangement the scoriæ, gases, and other extraneous matters may be expelled from the plate while the metal is at or near the welding point, and thereby blistering or other unsoundness in the plate, bar, or other manufactured article is more effectually got rid of. In combination with this arrangement, Mr. Napier proposes to use vertical or oblique rolls, to give the metal any required shape.

Preparing the Ends of Welded Tubes.—Mr. J. J. Russell, of Wednesbury, proposes, in place of heating the tubes as heretofore, to employ a bath of fluid lead, or other suitable metal, into which the ends of the welded tubes are immersed, and by these means they are readily and very uniformly heated to the extent desired, which cannot be the case when fire is used. The ends of the tubes when heated are forced into powdered coke, sand, &c., to exclude the atmosphere whilst they are becoming cold.

Powerful and Compact Caloric Engine.—An exceedingly compact and well-constructed motive engine, on the Ericsson or caloric principle, has been recently constructed by Messrs. Fawcett, Preston, and Co., at the Phœnix Foundry, and is remarkable for the general efficiency of its working. The engine consists of two parallel horizontal cylinders, each 32in. in diameter, with a stroke of 15in. A regulating fly-wheel works in the central space between the two cylinders, and the estimated pressure is 8lbs. on the square inch. The space occupied by the whole is about 9ft. square, and to the top of the fly-wheel is also about 9ft., so that, with the exception of the two flues, the whole working space occupied by the engine will be represented by a cubical space measuring 9ft. on each side. The consumption of coal is estimated at 600lbs. per day; yet with this small amount of combustion, and in the limited space mentioned, it is capable of working up to 8-horse-power. The engine is intended to drive the machinery of a silk manufactory in Spain, for which purpose the owner got a smaller one on the same principle made some time ago, but having occasion to enlarge his works, he is now getting an engine of greatly augmented power to facilitate his operations. The engine in question seems admirably suited for any purpose, and to any place in which economy of space and comparatively large power are essential, and where water and fuel are scarce; as a motive power for working a printing-machine it seems to be most happily adapted. It worked with the greatest steadiness, and was smooth and equable in all its movements, but, unfortunately, it is somewhat noisy.

Slate Dressing Machines.—At the Maen Offeren Slate Quarries, Festiniog, some improvements in the machinery for cutting and trimming the edges of the slates, has lately been introduced, and a patent for its invention has been obtained. The machine consists of a wheel in the form of an ordinary fly-wheel, working upon horizontal axes fixed on a strong frame, with two, three, or more knives for cutting and trimming the slates, fixed at equal distances on the sides of the wheel, or if two slate cutters work at the same wheel then another set of knives may be fixed upon the other side of the wheel in alternate order. The knives should be fixed at such distances from the spokes of the wheel as to admit of the slate being presented to the knife without the projecting end coming in contact with the spokes of the wheel. The knives should be of sufficient length to cut the sides of the largest slates in ordinary use. They may be fixed either parallel to the spokes of the wheel or diverging slightly from them, but radially from the axis of motion, so that the inner end of the knife shall first come in contact with the slate. The slate to be cut is rested obliquely on a cutting edge fixed on the framework of the machine, and receives the revolving knife progressively from its inner to its outer extremity, as from a pair of shears. The knives to make progressive cuts more gradual, may be slightly curved upwards, like a scimetir. The size of the slate is regulated by gauges, as usual. The knives may form the spokes of the wheel, but he prefers them, as described, a short distance from the spokes.

PROGRESS OF HULL.—Some interesting results are disclosed in some statistics just prepared with respect to the progress of the town and port of Hull. In 1861 the population was returned at 109,000, and this year it is estimated at 110,800, while in 1836 it was only 65,000, the increase in 26 years being thus 45,800. In 1860 the tonage of the shipping entering the port was 833,633 tons, as compared with 490,044 tons in 1836; and the clearances outwards were 798,217 tons in 1860, against 421,938 tons in 1836, showing an increase of 376,279 tons. In 1860 the tonnage of the vessels subjested to the dock dues was 1,215,203 tons, and in 1837 it was only 535,022 tons, showing an increase of 680,181 tons, or 133 per cent. In 1836 the area of the dock accommodation is 23a. 0r. 39p. while now the area of dock accommodation is 40a. 5r. 28p.; and the area of the proposed new West Dock is 17a., and the increase to the Victoria Dock, 6a. In 1860 the number of steam vessels entering inwards was 1182, with a total tonnage of 350,922 tons, as compared with a total of 716 steamers, of an aggregate burthen of 225,110 tons, in 1855; and the number of steamers clearing outwards in 1860 was 1191, of a total burthen of 364,290 tons, as compared with 772, of an aggregate burthen of 212,986 tons in 1855.

NAVAL ENGINEERING.

THE "SHANNON," screw frigate, resumed her experimental screw trials at Portsmouth, on the 31st May last, with a screw of four blades fixed at equidistant intervals round a sphere or boss, similar in character to the Griffiths boss, having a diameter of 18ft., and a pitch of 23ft. 10in. The blades were cast from patterns of the blades of the Mangin screw, which was tried on the 17th of May last, particulars of which appeared in our last. The screw tried and the Mangin had therefore the same number of blades differently disposed. The blades of the Mangin, instead of being distributed round the circumference of the boss, as in the case of the screw tried on the 31st May, had one set of blades set behind the other, and thus retained the principle of a lifting screw, which the one tested on the 31st necessarily was not. It requires a less aperture or well in the ship's stern than our common Admiralty screw, for lifting it when putting the ship under sail. From the proximity of the Mangin's sets of blades to each other, the distance being only about 30in., the water became "locked" between them when working at full speed of the engines, and caused an excessive vibration throughout the ship. The ship left the harbour drawing the same depth of water as on her last trial—20ft. 3in. forward, and 21ft. 9in. aft. The weather, like that experienced on the three preceding trials, was as favourable as it could possibly be for developing the powers of a screw. On reaching the light vessel the ship's head was brought round and laid for the trial ground in Stoke's Bay, where six runs were made. The following were the results:—First run—time, 5 min. 4 sec.; speed, 11·481; revolutions, 53. Second run—time, 5 min. 32 sec.; speed, 10·843; revolutions, 52½. Third run—time, 4 min. 48 sec.; speed, 12·500; revolutions, 53½. Fourth run—time, 5 min. 50 sec.; speed, 10·286; revolutions, 54. Fifth run—time, 4 min. 36 sec.; speed, 13·043; revolutions, 53½. Sixth run—time, 5 min. 54 sec.; speed, 10·169; revolutions, 53½. The mean speed of the six runs was 11·553 knots. In the trial of the common screw, with its leading corners cut, on the 16th of May, a speed of 11·288 knots was realized with a maximum of engine revolutions of 59½. In the second trial, on the 17th, with the Mangin, the speed was 11·331 knots, with a maximum of engine revolutions of 53½. The third trial was made with the common screw, having both leading and following corners cut, and gave a speed of 11·062 knots, and a maximum of engine revolutions of 54. The fourth trial is the present one, which, it will be seen by a reference to the figures quoted, is so far the first in point of speed. The runs being concluded, the time in which she made a complete circle, both to port and starboard, was next taken. The helm was first hove over to port, which was done to one and a-half turns of the wheel, and with the rudder at an angle of 13 deg., in 29 sec. The first half of the circle was made in 3 min. and 29 sec., and the full circle completed in 7 min. and 12 sec. The helm was next hove over to starboard, with one and a-half turns of the wheel, and the same angle of rudder obtained in 43 seconds. The half circle was then made in 3 min. 41 sec., and the full circle in 7 min. and 50 sec. There was here a difference in time of 14 sec. in getting the rudder over to the same angle in going round to port and starboard, and a difference of 32 seconds in making the two circles. The peculiar action of the screw observed on this occasion, may have something to do with this difference in time, it raising a ridge of water across the ship's stern from port to starboard to a height of about 12 inches above the ship's line of copper, with, of course, a following current in the same direction over the screw. There was an almost total absence of any vibration, however, and a remarkably small rise of water in the screw well. The "beat" of the screw, which was so marked a feature of the "Mangin" screw, could not be detected in any part of the present trial; its action in revolving through the water being apparently perfectly continuous and equable. The column of water discharged astern of the ship by the screw was also less spread than is usually the case, and confined nearly to a line with the ship's course. The slip of the screw was also much less than either of the three preceding ones, being only about two knots.

ON THE 10th ult., this screw frigate resumed her experimental screw trial at Portsmouth, with the common or Admiralty screw. An increase of speed was anticipated, but the result was a loss as compared with her former trial with the same screw. The ship drew 20ft. 2in. of water forward, and 21ft. 8in. aft., six runs were made at the mile, with results as to speed as follows:—First run, 11·501 knots; second run, 10·557; third run, 11·726; fourth run, 9·625; fifth run, 12·727; and sixth run, 9·424 knots. The first means were 11·029, 11·141, 10·675, 11·173, and 10·072 knots; the second means were 10·086, 10.907, 10·924, and 11·122 knots; the mean speed of the whole was 11·009 knots. The revolutions of the engine ranged from 57 to 58½. In making the circles, the ship, with the helm passed hard-a-port, made the first half circle in 3 min. 43 sec., and the full circle in 7 min. and 50 sec.; with the helm hard-a-starboard, the first half circle was made in 3 min. and 10 sec., and the full circle in 7 min. and 20 sec. In the first the revolutions of the engines were 57, in the latter 56.

On the 16th ult., the *Shannon* steamed out of Portsmouth harbour in the morning, having previously been fitted with a six-bladed screw, to test the excellence of this invention. On arriving at Stoke's Bay she made six runs at the measured mile, drawing 20 feet 2 inches of water forward and 21 feet 9 inches aft. The result of these runs gave a speed of 11¼ knots per hour, the mean revolutions of her engines being 49 per minute. The first circle, with helm hard-a-port, was described in 7 min. 8 sec., and the second, with helm hard-a-starboard, in 7 min. 57 sec. Revolutions of engines 48 per minute. There was no vibration, but the trial, as far as the speed was concerned, was not so successful as the previous trial.

THE "ROYAL OAK."—The Lords of the Admiralty have given directions for the *Royal Oak* 51 guns, building at Chatham, to be sheathed with Muntz's patent metal, the reports received respecting the durability of that desciption of sheathing, which was applied to the Bombay, 81, and the *Arethusa*, 51, being highly favourable. The workmen have already commenced fixing the new metal on the rudder of the *Royal Oak*. The Admiralty have abandoned the intention of having iron rigging for the topmasts, and the ordinary rigging is to be fixed.

NAVAL STRENGTH OF FRANCE.—Official reports respecting the strength of the naval forces of France were issued on the 4th, ult., and presented to both Houses of Parliament. From this statement it appears that, of the French steam navy there were, on the 1st January, 1862, 319 vessels afloat, and 41 building; total, 360; of this number 36 are ships of the line, 6 iron-plated frigates, 24 screw, and 18 paddle frigates. The steam navy in commission included 14 ships of the line, 4 iron-plated frigates, and 14 screw frigates, 15 gunboats, including, with corvettes, avisos, and transports, a total of 172. The French sailing navy on the 1st of January, 1862, comprised 119 vessels, 3 building, total, 122; of which there were seven ships of the line, 23 frigates, 12 corvettes, 19 brigs, 26 small vessels, transports, 32. The sailing vessels in commission numbered 63, including one ship of the line, nine frigates, three corvettes, and five brigs. From a return of iron-plated ships and batteries building, it appears that on the 1st of January 1862, there was in course of construction at Toulon three vessels of this class, viz., the *Provence*, *Savoie*, and *Revanche*, all of 36 guns and 900-horse power. On the first of these vessels, it is stated, there are "a fair number of men employed;" while on the other two, very few men were working. At Brest one iron-plated ship, the Gaulouse, 36 guns, was "progressing slowly;" two other vessels of the same calibre, at Brest, were building. At Lorient the frames of two iron-plated ships are nearly completed. At Rochefort one vessel is reported in construction, though "little is doing to the ship." At Bordeaux two batteries are being built, of which the engines "are in and ready for launching, but left on the stocks to season; not entirely plated." In addition to the above, given in a tabulated return, Captain Hore, in the despatch of Lord Cowley, dated April 4, states that, in a lithographed list of the French navy of 1862, just published, the names of seven new floating batteries of 150-horse power are given as building at Bordeaux and Nantes. These batteries were under consideration in October last. The iron-plated frigates on the stocks, Captain Hore says, are represented as intended to carry 38 guns with 1000-horse power; the Gloire class carry only 36 guns and 900-horse power. Three new corvettes are being built at Brest and Lorient, and have been lately laid down. In a subsequent despatch, Captain Hore gives the normal and extraordinary budgets for the French navy for 1863. The sum asked for in the normal budget is 126,418,920f. (£5,056,756), in the extraordinary budget 17,000,000f. (£680,000); the whole being in excess of budget proposed for 1862 by 18,773,501f. Captain Hore also states to Lord Cowley, under date May 1, that a large supplementary credit of between £2,000,000 and £3,000,000 is about to be opened to meet the current expenses of the French navy of this year. The expeditions to Cochin-China and Mexico have caused a large increase of the number of seamen embarked.

THE AMERICAN GOVERNMENT SUBMARINE VESSEL.—The little submarine hand-propeller is 46ft. in length, about 6ft. deep, and 4ft. 6in. in breadth. In shape and appearance she is very much like a large iron boiler, flattened, with a tapering or conical end, and rounded stern. A sheet iron horizontal guard runs around the outside of the vessel, under which the hand paddles, 8 on a side, are attached. These are two-leaved, and the leaves close on a hinge on the upward or back stroke, to avoid the resistance of the water. Their handles, to which the paddles are at right-angles, pass through the iron sides of the vessel, and are moved by the rowers, the iron rod or angle acting a hinge. Inside, she looks somewhat like a bomb-proof man-of-war barge, with white painted iron thwarts crossing at regular intervals, and her arched iron roof perforated with small glazed apertures. On her conical bow is a water-tight compartment, connected by a small door with the main interior space, and having in the bottom a little round door, called a "man hole," through which a diver, in submarine armour, may descend to the bottom of the water, and carry on his destructive work at leisure and unobserved. There is a fan-like rudder, of a crescent shape, hinged on the stern, fastened at its horns to the top and bottom of the end. The vessel contains pumps, an air-condenser, anchors, &c., and is entered by a "man hole" on the top near the bow.

STEVENS BATTERY.—The Secretary of the Navy in a report to the United States Congress, says he does not feel authorized to expend the sum voted to carry out the suggestions recommended by the congressional committee.

THE AMERICAN NEW IRON-CLAD STEAMER "IRONSIDES."—The "streaks," or bands of iron plating of this vessel, are 28in. broad. They commence four feet below the water-line. On the bows and stern the plating will be three "streaks," or seven feet broad. Amidships, as far as the port-holes extend, they will reach from below the water-line to the bulwarks, and eight "streaks" broad. These have been laid on at the rate of one in fourteen days. The ram consists of a continuation of the two lowest "streaks" meeting from the two sides of the bow, bolted together, and projecting beyond it four feet ten inches. Its dimensions are thus, the height, 56in.; thickness, 9in.; and length, 4ft. 10in. There are 360 men now engaged upon her. This vessel is the largest armed Government vessel afloat. She has a larger tonnage than the ship-of-the-line *Pensylvania*. She will draw 15ft. of water, with ten days' fuel and her full armament on board. Her beam is much greater than the usual proportion in war vessels. While having the capability of a sea-going vessel, she is more especially adapted for coast and harbour defence. The aggregate weight of the plates will be seven hundred and fifty tons.

NAVAL APPOINTMENTS.—The following have taken place since our last. J. G. Oakshott, Chief Engineer, to the *Hastings*; E. W. Baker, Chief Engineer, to the *Indus*, for the *Donegal*; G. Mills, Engineer, to the *Cumberland* for the *Lily*; W. Laird, Engineer, to the *Asia*, for the *Nimrod*; W. H. Mothersole, Engineer, to the *Cumberland*, as supernumerary; T. T. Andrewartha, and James Rose, Acting Second-class Assist. Engineers, to the *Asia*; W. Greenhill, Acting Second-class Assist. Engineer, to the *Cumberland*; R. J. Roberts, Engineer, to the *Dromedary*; J. F. Morton, and C. F. Lacy, First-class Assist. Engineers, to the *Indus*, as supernumeraries; W. Powen, First-class Assist. Engineer, and N. F. Hockerston, Second-class Assist. Engineers, to the *Dromedary*; J. K. Weatherley, in the *Snap*, and G. Lawrence in the *Asia*, confirmed as Second-class Assist. Engineers; W. H. Lowman, for the *Rapid*, promoted to Engineer; J. Spinks, in the *Scylla*, promoted to Acting Engineer; G. R. Beer, for the *Advice*, and W. Hair, in the *Magpie*, confirmed as Second-class Acting Engineers; T. Jeans, and J. Rice, First-class Assist. Engineers, to the *Rifleman*, and the *Swinger* respectively; W. Pitt, Chief Engineer, and J. P. Lloyd, and G. W. Robins, First-class Assist. Engineers, to the *Sanspareil*; J. Campbell, G. Weight, T. Pokton, and J. Murray, Acting Second-class Assist. Engineers, to the *Victory*, for the *Sprightly*, to the *Victory*, for the *Firequeen*, to the *Cumberland*, for the *Wildfire*, and to the *Asia*, respectively; J. Redgrave, and T. Coombs, Acting Second-class Assist Engineers, to the *Cumberland*; J. J. White, Acting Second-class Assist. Engineer to the *Asia*, for the *Echo*; W. T. Goldie, J. Manby, and James MacGregor, confirmed as Second-class Assist. Engineers, in the *Cumberland*, *Shannon*, and *Doterel*, respectively; J. Shiel, Acting Second-class Assist. Engineer, to the *Asia*; W. Lowman, Engineer, J. Paterson, First-class Assist. Engineer, and G. O. O'Brian, Second-class Assist. Engineer, to the *Rapid*; R. Dobson, confirmed as Second-class Assist. Engineer; H. Lanckester, to the *Dauntless*, for the *Leveret*, vice Smith; T. Smith (B) to the *Euryalusas* as supernumerary, vice Lanckester; W. Read, Acting Second-class Assist. Engineer, to the *Asia*; W. M. Chambers, in the *Cumberland*, for the *Pylades*, confirmed as Chief Engineer; E. Taylor, supernumerary in the *Fisgard*, promoted to Engineer; G. Tucker and A. H. Miller, Chief Engineers; E. Pearce, W. Burgess, and H. F. Saunders, Engineers; J. C. Williams, and J. Jessop, First-class Assist. Engineers; J. E. Turner and G. W. Hancock, Second-class Assist. Engineers; J. R. R. Potam and W. R. Macavoy, Acting Second-class Assist. Engineers, to the *Black Prince*; R. Oliver, J. Brown, and H. Hollingsworth, promoted to First-class Assist. Engineers; A. G. A. Billowes, T. Haywood, J. B. Stephens, T. Clark, W. Inglis; and T. Summers, promoted to Acting First-class Assist. Engineers; G. E. M'Keeg and S. Chauker, confirmed as Second-class Assist. Engineers.

STEAM SHIPPING.

THE "GREAT EASTERN."—At the special meeting of the proprietors of the Great Ship Company on the 18th ult., a satisfactory report of the voyage to and from New York was presented. The passengers had been satisfied in every way. The earnings of the homeward trip had exceeded the expectations of the New York agents, and had amounted to £11,102. The directors believed that the employment of the ship in the New York trade would prove remunerative, and they had advertised her to sail for America on the 1st of July and the 16th of August. The chairman congratulated the proprietors on the satisfactory character of the voyage, and anticipated for the ship a successful career. Captain Paton, the commander, bore high testimony to the qualities of the vessel; and the report, after a brief and harmonious conversation, was adopted. The £4000 of the second series of debentures, which had not been previously taken up, were subscribed for before the meeting terminated.

FEATHERING *v.* COMMON PADDLE WHEELS.—The *Enterprise*, of Dundalk, an iron paddle steamer, of 900 tons, B.M., and 300 H.P. (nominal), the property of the Dundalk and Liverpool Steam Packet Company, plying between the above ports, has had the wheels, which were on the common principle, taken out, and replaced by a set on the feathering principle, designed and constructed by Messrs. J. and G. Thomson, Glasgow, on their most approved principle. Previous to the above alteration, the speed of the vessel was 11½ statute miles per hour, and on being tested at same draught of water, and under similar circumstances, the speed was found to be 14½ statute miles per hour, or a difference of 3 miles in favour of the feathering principle, being full 25 per cent.

THE TRIAL TRIP OF THE "LONDON."—This fine iron steam vessel, built some time ago by Messrs. Leslie, at Hebburn Quay, and intended for the Spanish trade, left the Tyne on the 16th ult., for a trial trip, and proceeded as far north as Coquet Island, in the course of which her sea-going qualities were thoroughly tested, as far as practicable under the circumstances, and the merits of the ship were fully acknowledged by all practical men on board. This fine specimen of naval architecture is 250ft. in length over all; 31ft. breadth of beam; depth of hold, 25ft.; tonnage, 1300; and her engines are 150 nominal horse-power. The ship is fitted up with Spencer's surface condensing engines, built by Messrs. R. and W. Hawthorn. Although the engines are nominally 150 horse-power, they can be worked up to from 480 to 550 indicative horse-power, and the consumption of fuel will not exceed eleven hundred weight per hour. Engines on this principle, to the amount of 6000 horse-power, have been already supplied to various vessels, and the plan of surface condensation has been adopted by various eminent shipbuilding firms. Messrs. Hawthorn, of Newcastle, were among the first to adopt the system, and, notwithstanding the difficulties incidental to all new arrangements, and the objections made to the new plan, the employment of surface condensing engines has of late made rapid progress. The ship, which is barque-rigged, and capable of carrrying a great amount of canvass, is fitted up with all the latest appliances. In her progress northwards, as far as the Coquet, the *London* attained the average speed of eight knots an hour, with the engines working at about sixty-four revolutions per minute. This, for a first performance, was considered very satisfactory. It is expected that the average revolutions will be at the rate of seventy-six per minute, with a speed of 10½ knots an hour. In the run home, the ship made nine, knots an hour, with the engines working at 68 revolutions per minute. During the trial trip, the steam pressure varied from 25 to 30 pounds to the square inch, with a steady vacuum of 27in. The diameter of the cylinder is 43in., with a stroke of 2ft. 9in., and is fitted with separate expansion valves and steam jackets. The behaviour of the ship during the run out and home appeared to give the greatest satisfaction to her builders and owners.

THE "SHUN LEE."—The official trial of this screw steamer recently took place on the Clyde. The trial of speed was on the measured distance between the clock and Cumbrae lights. The distance was run against the tide and a strong breeze of wind, in 1 hour 19 min., 5 sec., and with the tide in 1 hour 10 min. 13 sec., or at the rate of 11 knots per hour. The consumption of coal for three hours when the vessel was going at the above speed, was found to be 10 cwt. 3 qrs. and 9 lbs. per hour. The *Shun Lee* then proceeded to the measured distance up the Garebock, where there was no tide, and nautical mile was run nearly in 5 min. 3 sec., making 12 knots per hour. The dimensions of the *Shun Lee* are 185ft. by 28ft.; tonnage, B. M., 588, fitted with a pair of direct acting inverted condensing engines, and tubular boilers of 120 horse power. The engines are fitted with separate expansion valves. During the trip the average draught of water was 11ft. 10in., with a cargo on board of 470 tons weight. The result of the trial was most satisfactory to all concerned. The *Shun Lee* was built and designed by Messrs. Blackwood and Gordon, of Port Glasgow.

THE "ISABELLA," a new steamer built in the yard of Messrs. J. Wigham Richardson and Co., Low Walker, was tried upon the Tyne on the 10th ult. The *Isabella* has been built for the purpose of navigating the river Vistula above and below Warsaw, where she will be solely employed as a towboat for towing the numerous grain barges which are found upon that stream. In order to make her specially applicable to this service she has been constructed in a somewhat novel manner. Power rather than speed has been aimed at; as the waters of the Vistula are in many places very shallow, the boat has been built with the lightest draught possible. Her dimensions are as follows:—Length, 135ft.; breadth, 14ft.; draught of water, 16in. She has oscillating engines of 60 H.P., and is fitted up with steering and other apparatus of the most perfect description. The paddles are placed more aft than is usual; and in order to provide rooms for the cabins, the fore deck is raised about a couple of feet above the aft deck. On her trial she was found to answer her helm well, and to be in every respect a success.

RAILWAYS.

RAILWAY TRAFFIC IN ENGLAND AND FRANCE.—It is stated as a remarkable fact that, while English railway traffic is experiencing a considerable decline, the receipts of the French systems are advancing at the rate of £20,000 per week. The increase of mileage in England is only some 250 miles, while in France it is about 350 miles, but the odd 100 miles will hardly present an explanation of a variation of traffic to the extent of at least £40,000 per week. It must be remembered, however, that France was behind England in the extension of railways, and may be said to be only now developing its railway traffic as England was doing years ago.

NORTH OF SPAIN RAILWAYS.—The works on this important system of railways are being pushed forward with great vigour. The object now aimed at is the completion of the line through the ridge of the Guadarama, as, that effected, direct communication will be established between Madrid and the Castiles. Upon the passage of the Guadarama 13,750 men were employed in April last, as compared with 5700 six months previously. The bulk of the capital required for the undertaking being furnished from French sources. French firms are now supplying the principal portion of the rolling stock and plant. Efforts are being made to organize repairing shops, &c., supplied with Spanish mechanics, so that the English element is now very little represented in the undertaking.

RAILWAY EXPERIMENTS.—M. Girard, under the patronage of the Emperor, has constructed an experimental railway on which the carriages are impelled after the manner of a sledge. The runners of the sledges rest on a species of hollow clogs, between which and the rails water is introduced. Thus the carriages slide on a thin layer of water, and friction is almost annihilated. The success of this experimental railway is stated to be so decided that a commission has been appointed to report on the system.

THE VICEROY OF EGYPT has purchased Messrs. Sharp, Stewart and Co.'s locomotive in the Exhibition, and with it six more of the same pattern.

The South Eastern, Eastern Counties, Lancashire and Yorkshire, Newcastle and Carlisle, North British, Caledonian, Edinburgh and Glasgow, and other railways, now test all their locomotives with hydrostatic pressure up to twice the regular working pressure. The old boilers are tested as well as the new, in some cases as often as twice a year.

RAILWAY WORKS, &c., IN PORTUGAL.—A fine bridge, which crosses the Tagus, on the Lisbon and Badajoz line, has just been terminated. The bridge, which has been constructed in 18 months, is formed entirely of iron, and it has 16 openings, each of 100 feet span. The piles on which the structure is placed are composed of two cylindrical iron tubes, 5ft. 4in. in diameter, and they have been sunk at a distance of about 6ft. 8in. from each other. For the purpose of securing greater solidity and strength, they are strongly bound together with ironwork. In two months locomotives will thus be enabled to cross the Tagus at a height of more than 50ft. above the ordinary level of the river, and with the same security as on any other part of the line. The Lisbon and Badajoz line forms part of the Royal Portuguese system now in course of rapid construction, under the direction of French engineers. The system must not be confounded with the South-eastern of Portugal, which exhibits a locomotive in the machinery *annexe* of the International Exhibition. From Badajoz the line will be carried by another company to Ciudad Real, across the South of Spain, while in another direction it will be connected with Madrid. The railway navvy is now hard at work throughout the Spanish peninsula, and although personally he is rather a rough diamond, he cannot but be regarded as the agent of modern civilisation.

THE MONT CENIS TUNNEL.—Recent accounts of the gigantic tunnel through Mont Cénis state that the works are progressing favourably. It is ascertained that the tunnel will exceed eight English miles in length, and will pass under the ridge of the mountain at a depth of a full English mile below the surface. Shafts being out of the question, the tunnel will be ventilated by compressed air, driven into it by machinery worked by water-power, which, it is calculated, will drive about 51,000 cubic feet of compressed air into the tunnel daily. According to the present rate of working, the tunnel will not be finished under six years; but it is intended to increase the power of the boring machines, and to make them work more expeditiously.

IMPROVEMENTS IN BRIDGE RAILS.—Improvements have been made in this class of rail, by Mr. Thomas Ellis, the manager of the New Swindon Rail Mills. The rail is considered to be well adapted both for longitudinal and cross sleepers, and will never alter its shape, as the old rail does. The latter rails are generally filled with oak, to prevent them coming in, but this Mr. Ellis finds soon perishes, and the rail closes so much as to cut off the bolts and destroy the timber; this is done away with in his rail, and the timber is considered by practical engineers to last a much longer time, as the rail has a solid base. The cost and weight will be the same as the original rail, whilst it has the advantage of not moving at the joint, so that it cannot throw the engine off.

LARGE IRON RAILWAY BRIDGE FOR INDIA.—Messrs. Ormerod, Grierson, and Co., of the St. George's Ironworks, Hulme, have lately completed the first of a series of 12 spans, which are to constitute an iron lattice bridge over the river Jumna, near Delhi. The bridge is for the East India Railway Company, and is from designs by Mr. A. M. Rendel, C.E., London. It is so constructed as to answer the double purpose of a railway and an ordinary road, the railway being along the top and the roadway beneath it. Each girder is 216ft. long, and this gives a clear span of 205ft. between the piers, of which there will be 11. The 12 spans will, therefore, form a structure having a total length of over half-a-mile. The first span has been completely rivetted up in the works, and loaded with nearly 450 tons of pig-iron. The deflections were carefully noted, but the details would not be of general interest, and it may be sufficient to state that the result of the test was even more favourable than was anticipated. The iron has been supplied by the Shelton Bar iron Company, near Stoke, and was required to bear a tensile strain of 21 tons to the inch of section. The breaking strain is estimated at from 2500 to 3000 tons equally distributed, which leaves ample margin beyond any weight to which it will be subjected. The bridge, notwithstanding its great length, has a light and airy appearance.

RAILWAY ACCIDENTS.

ACCIDENT ON THE LONDON CHATHAM AND DOVER RAILWAY.—On the 10th ult., an excursion train left Sheerness, Sittingbourne, and several other stations below Chatham, at nine o'clock in the morning, the train being a heavy one. On arriving at the Chatham station, which is reached about ten o'clock, five additional carriages, all filled with passengers had to be added to the train, raising the number of carriages to seventeen. It was then found necessary to attach another engine to the train, and to enable this to be done the excursion train had to be backed down the up-line into the Chatham-hill tunnel. The station-master, knowing that a heavy excursion train from Dover to Victoria was about due, directed the telegraph clerk to forward a message to the next down station, New Brompton, with orders to stop the Dover train until the line was signalled as clear, and it was not until the message had been despatched that the train was backed into the tunnel. From some inexplicable mistake, however, the Dover excursion, which almost immediately afterwards arrived at New Brompton, was not stopped, but allowed to continue its journey to Chatham, towards which it was proceeding at its usual rate of speed. The servants at the Chatham station are positive in their statements that the signals on the down side of the tunnel were against the train; but whether this were really the case or not the driver of the Dover excursion ran into the tunnel, and in the space of a minute came into violent collision with the other excursion train. It was fortunate that the train was going at something under ten miles an hour, or the loss of life must have been very great, as there were upwards of 1500 passengers in the two trains. As it was, the shock of the two trains was so great, that many persons were seriously injured, though none fatally.

MILITARY ENGINEERING.

THE ARMSTRONG GUN, 40-pounder, employed for some time past in Woolwich Arsenal, in testing a new species of vent pieces, and loaded with a double proof charge of powder and shot, has at length yielded to the tremendous concussion, and burst, the whole of the coils behind the trunnions having been shattered into fragments. Admiralty orders have been received at Chatham for spare vent-pieces to be in future supplied to all Armstrong guns on board the various ships, in the proportion of three each to the 100-pounders, 70-pounders, and 40-pounders, and two each to all guns of a smaller size.

THE WAR ROCKET.—Lieut. Col. Parlby has lately published a statement of the circumstances attending his endeavours to improve the construction of the war rocket from the year 1814, while serving in the Bengal Artillery, up to the present time. It is to be hoped that a fair scope will soon be given to allow Col. Parlby, who has spent a lifetime in vainly endeavouring to overcome the prejudices of the "powers that be," to introduce into the service his improved construction of War Rocket, for it is well-known that the present service rocket is, to say the least, a very imperfect weapon. Col. Parlby in the published statement we have referred to, says that in the preparations for the Bhurtpore campaign, the Congreve rockets in store were found to be so unserviceable and even dangerous to our troops, that on the earnest recommendations of the military authorities and the military board, Government determined, in 1826, that Col. Parlby should form a rocket manufactury attached to the gunpowder works at Poppermhow, near Allahabad, of which he was then the superintendent. But unfortunately, after incessant labour, in a very trying climate, and having, without any European assistance brought his manufactory near to perfection, on Lord Wm. Bentinck's arrival as Governor-General in 1828, being determined to carry retrenchments to the extreme, both the gunpowder works of Ishapore and at Allahabad, involving, of course, the rocket works, were ordered to be closed for a period of three years, or more, and the establishment discharged at a month's notice. India was said to be at peace, but how long this calm continued, history tells us. Since that time Col. Parlby has made several attempts to induce the authorities in England to allow him to prove the superiority of his construction of rocket, but in vain. Having, however, every reason to believe that even to this day there is a strong impression (if not conviction) that he gained his knowledge of the manufacture of rockets from the plans of Sir William Congreve, as in fact that officer accused the Colonel of doing. Col. Parlby affirms:—1st. That from the first rocket he made, he gave the rifle motion, which Sir William Congreve's have not. 2nd. That there is an essential difference in the form of his cases. 3rd That the compositions of his rockets, as well as the manner of applying them, are different. 4th. That there is a perceptible difference in the flight of the two missiles, too evident to suppose a similitude. 5th. That in no instance has any rocket of his construction, turned backwards, or deviated from the true line of flight more than a few feet at the utmost, so that in several communications from Captain Graham, from Meerut, he declared the flight of Col. Parlby's large rockets to be equal to that of the average mortar practice with shells. Finding, however, from trustworthy reports, that the rockets made at Woolwich are still defective in many essential points, and that the supplies sent to India since he came away, have proved in some instances worse than unserviceable, he feels the earnest desire, if means are furnished him, to improve a weapon, which cannot fail, if properly formed, to be a formidable auxilliary to artillery by sea or land, as originally expected; and he is ready to come forward with all his aid and experience, for this purpose. To show that improvement is necessary, it may be stated here that in the course of "Artillery and Fortification," published by authority, 1860, for the use of the Royal Military College, Sandhurst, by Captain Boxer, now superintending the Royal Laboratory at Woolwich, he thus concludes his notice of the war rocket. "The present service rocket has one serious defect, namely, "great irregularity of flight." If this be overcome, the rocket would be a most formidable weapon, if used in large numbers." The following extract from a general officer's letter from India, will also show the utter and disgraceful failure of the Congreve rocket on a most important occasion:—"In the battle of Golowlie, the day before the action and the capture of Calpee, in Bundlehund (the General says), "at the moment of the advance of a dense mass of the enemy's cavalry on the 22nd May, 1858, our rocket firing was a perfect failure. One or two rockets hissed off from the tubes towards the enemy, and then suddenly buried themselves in the ground, and one or two others whizzed about erratically in the sky and then turned back upon their friends who had wished them good speed; so the General, Sir Hugh Rose, now Commander-in-Chief in India, ordered these dangerous things to the rear." Col. Parlby concludes his statement by asserting that he is ready to prove that it is perfectly easy to make rockets of 500 pounds to 1000 pounds or upwards, if required, only requiring an earthern ramp, and wooden or iron trough, to range as well as the best shells from mortars.

Dockyard, &c., Defences.—The construction of the various defences for the protection of Pembroke Dockyard, and the Haven at Milford, have been vigorously carried on during the spring. Batteries are now in course of erection in four commanding sites, viz.:—Popton Point, Hubberstone Point, and South Hook Point, while new fortified barracks are in progress at Scoveston. Upwards of 500 men are engaged on these fortifications.

TELEGRAPHIC ENGINEERING.

The Atlantic Telegraph.—The paddle-wheel steam surveying vessel *Porcupine*, 3, Master Commander Hoskyn, at Devonport, appointed on the application to the directors of the Atlantic Telegraph Company to take soundings in the Atlantic, will be provided with a donkey-engine on deck to assist the men. The machines which will be used are those called the "Bull-dog," machines. They are constructed on the principle best adapted for bringing up portions of the bottom. Broke's apparatus, will also be employed. The *Porcupine*, it is expected, will in the first place proceed to that part of the Atlantic where there is what is popularly called a cliff in the bed of the Ocean, at which point it is supposed the former cable was broken. At the head of this declivity, about 200 miles from Ireland, there is a depth of 550 fathoms, and at the foot 1750 fathoms, showing a difference of 1200 fathoms. But this decline extends over a distance of eight miles, so that the fall is only one in eight. Other portions will, no doubt, be sounded. It is stated that in the event of a second attempt to establish telegraphic communication across the Atlantic some place on the coast of Ireland, further north than Valentia harbour, will be selected for the purpose of obtaining a more convenient bed for the reception of the wire. The burden of the *Porcupine* being only 382 tons, she is rather small for the duty. The donkey-engine alone will weigh ten tons, and this, with the fuel necessary to be kept near it on deck, may cause her to roll, especially when her stock of coal is diminished. While employed sounding very little coal will be expended, but as, she cannot stow above 100 tons frequent communication with the shore will be necessary. Galway or some other western port in Ireland will be visited for this purpose.

BOILER EXPLOSIONS.

Manchester Association for the Prevention of Steam-Boiler Explosions.—At the ordinary monthly meeting of the Executive Committee of this Association, May 27th, 1862, the chief engineer presented his monthly report, of which the following is an abstract:—"During the last month there have been examined 316 engines and 464 boilers. Of the latter, 9 have been examined specially, 10 internally, 74 thoroughly, and 371 externally; in which the following defects have been found:—Fracture, 6 (3 dangerous); corrosion, 50 (7 dangerous); safety-valves out of order, 6; water gauges, ditto, 15; pressure-gauges, ditto, 5; feed-apparatus, 1 (dangerous); blow-off cocks, ditto, 34 (2 dangerous); inside plugs, ditto, 6; furnaces out of shape, 6—total, 129 (13 dangerous). Boilers without glass water-gauges, 29; without pressure-gauges, 10; without blow-off cocks, 34; without back pressure-valves, 33. It will be remembered that one of the late explosions arose from the failure of an angle iron, on which alone—as on a single thread—a large crown plate depended for its support. Several other explosions occurred to externally-fired boilers through failure of the plates just at the seam of the rivets exposed to the flame. In some of such cases the plate is found to crack at the rivet holes; in others leakage occurs, from which corrosive action sets in, and steadily continues until the plate becomes so thinned, that rupture and explosion ensue. Some explosions have occurred from corrosion, consequent upon external damps; others, from acidity of the water; while others again, of somewhat earlier date, have been occasioned by the collapse of the furnace tubes, consequent upon the weakness of construction, which would have been remedied by the adoption either of flanged seams, T or angle-iron hoops, or other similar means. Thus it will be seen that all the above explosions occurred from the most simple causes, and that no mystery whatever need be attached to any one of them; while by suitable construction of the boilers in the first place, and due attention to their state of repair in the second, these explosions would in every case have been prevented. Very few of the explosions that come under my notice occur from shortness of water, and I believe that to be a much-abused idea, and the number of explosions resulting from it to be much exaggerated. It appears to be an almost stereotyped verdict at inquests, and the boiler attendant being frequently killed, there is seldom any witness to the contrary. I find that by far the most frequent cause of explosion is the insufficiency of the boiler for its working pressure, either on account of its original construction, or state of repair consequent upon use; while those explosions resulting either from deficiency of water, or from extraordinary or reckless pressure, are comparatively rare. In other words, to prevent misapprehension, I find that explosion is more frequently due to weakness of the boiler, than to excessive pressure of the steam. I know no means of ascertaining the sufficiency of the original construction of a boiler, or of testing the weakness produced upon it by wear and tear—in short, of testing either new or old boilers—equal to the use of hydraulic pressure, and think all steam users would do well to make systematic use of this test once a year. In France, I believe, this plan is rendered compulsory by the Government, and it would be well were it generally adopted in this country voluntarily. Weak places in the plates may pass undetected, even on careful examination, while some parts may be inaccessible and concealed from view, but the hydraulic test is sure to detect and expose them all. Its timely application would have saved that most disastrous explosion which occurred some time since, here in Manchester, at a locomotive establishment, second to none in the kingdom for its high reputation, and since a defect passed unnoticed at such an establishment, where the construction of boilers, as well as the quality and strength of plates may well be supposed to have been thoroughly understood, it surely argues the necessity of the hydraulic test being generally applied. Mr. Muntz, a steam user of Birmingham, states in a letter published on the Millfield boiler explosion, that he has for years adopted, with advantage, the plan of an annual hydraulic boiler test, and considers it a duty he owes to his workmen in consideration of their safety. The application of the hydraulic test is so simple, and the pump required so small, that each steam user could provide himself with one at very little expense, or some parties might find it worth their while to take up the proving of boilers by water pressure as an itinerant speciality of engineering practice. This Association would be glad to assist in the general application of the hydraulic test, by inspecting the boilers when under pressure, and I feel convinced that, were the practice of this annual test generally adopted, which I trust it soon will be, explosions would become nearly, if not entirely, extinct."

GAS SUPPLY.

On the Igniting Point of Coal Gas.—In consequence of the recent explosion in Holland, Dr. Frankland has experimented on this subject, and the results arrived at are thus summed up:—1. Coal gas cannot, even under the most favourable circumstances, be inflamed at a temperature below that necessary to render iron very perceptibly red-hot by day-light in a well-lighted room. But this temperature is considerably below a red heat visible in the open air on a dull day. 2. This high igniting point of coal gas, under all circumstances, is due in a great measure to the presence of olefiant gas and luminiferous hydrocarbons. 3. The igniting point of explosive mixtures of the gas of coal mines is far higher that of similar mixtures of coal gas; consequently, degrees of heat, which are perfectly safe in coal mines, may ignite coal-gas; hence, also, the safety-lamp is much less in coal-gas than in fire-damp. 4. Explosive mixtures of coal-gas and air may be inflamed by sparks struck from metal or stone. Thus an explosion may arise from the blow of the tool of a workman against iron or stone, from the tramp of a horse upon pavement, &c. 5. Explosive mixtures of coal gas may also be ignited by a body of a comparatively low temperature, through the medium of a second body, whose igniting point is lower than that of coal gas. Thus sulphur, or substances containing sulphur, may be inflamed far below visible redness; and the contact of iron below a red heat with very inflammable substances, such as cotton waste, may give rise to flame, which will then, of course, ignite the gaseous mixture.

Purification of Coal Gas.—Dr. Thomas Richardson, Newcastle-on-Tyne, proposes to disolve the burnt sulphur ore left as a waste product in the manufacture of sulphuric acid in muriatic acid, and evaporating the solution to dryness, or to drying up the solution with sawdust, charcoal, small coke, gypsum, or the waste burnt sulphur ore, or other oxide of iron ground to powder, and to employ these mixtures with line or magnesia, in the usual way in the purification of gas.

Increasing the Illuminating Power of Gas.—Mr. W. J. Williams, Warnford-court provisionally specified an improved process of charging illuminating gas with the vapour of hydruret of carbon for the purpose of increasing its illuminating properties. He proposes to cause the gas in its passage from the meter to the burners to pass through a series of rows of perpendicular cords or threads saturated with hydro-carbon liquid by which it becomes charged with hydro-carbon vapour, and as the gas is liable to become overcharged with the vapour, and cause a waste of the hydruret of carbon, often becoming very troublesome by condensing and filling up the pipes obstructing the flow of the gas, and flowing out of the burners; when opened he causes the gas to pass through a condenser, where the excess of hydro-carbon vapour is condensed, and the liquid resulting from the condensation flows back to the evaporating chamber, or some other receptacle from which it can be returned to the evaporator, while the gas in a properly charged state passes on to the burners.

The City of London Gas Company last year carbonised 51,758 tons of coal, and and produced 481,000,000 cubic feet of gas.

The Hong Kong and China Gas Company.—A capital of £35,000 has been privately subscribed for an undertaking to be called as above, in 3500 shares of £10 each. The privileges of the company have been accorded by the Governor of Hongkong, and confirmed by the Colonial Secretary.

Sewage of Towns.—The select committee on sewage of towns have agreed to the following first report.—"1. That careful and exact experiments are necessary to elucidate the agricultural value of sewage, and the best mode of applying it. 2. That such experiments have been carried on at Rugby by the commission appointed to inquire into the best mode of distributing the sewage of the towns, and applying it to beneficial and profitable use. 3. That it is desirable that these experiments shall be continued during the present year."

The Brighton Sewerage.—A scheme of sewerage adequate to the wants of Brighton has at length been determined upon. The slovenly and highly disagreeable plan of running the sewage into the sea, to generate odours by the re-action of the salt water, has been wisely condemned. A main sewer will collect all the sewage of the town, and convey it to an outfall to the east of Rottingdean. At this point it will be discharged into the sea twice in twenty-four hours, and the current will sweep it eastward, avoiding the risk of annoying any inhabitants of the coast, and as the whole cutting will be through chalk, the construction will be easy and inexpensive. It is estimated that about £30,000 will accomplish this important undertaking. In accordance with the principles of the London main drainage scheme, provision is made for an outfall. But the plan is perfectly compatible with the utilisation of the sewage for agricultural purposes. At any part of its course through the main sewer leading to Rottingdean, it will be perfectly feasible to pump out liquid sewage and apply it to the land.

DOCKS, HARBOURS, CANALS, &c.

Chatham Dockyard.—In order to keep pace with the advance which has been made during the last few years in the size of ships, the new wet and dry docks and floating basins in course of formation at Chatham will be sufficiently capacious to receive vessels at least 100ft. longer than any of those now attached to the navy. The works now in progress will include three basins, the smallest of which will be larger than that at either of our Royal dockyards. The area of the three basins, exclusive of the additional large docks also to be constructed at Chatham, is considerably more than that of the total area of the docks and basins at all our dockyards, including two small basins at Woolwich and Deptford, which are altogether useless for large ships. The total area of the existing docks and basins at the various naval ports is 41 acres, but the three new basins to be formed at Chatham will give an area of 59½ acres, the largest basin being 30½ acres in extent, or about five times the size of the principal basin at Keyham, the largest of the kind in England. The second basin will cover an area of 22 acres, and a smaller basin, mid-distant between the two others, with which it is connected, will be seven acres in extent. The new works to be undertaken at Chatham will make that naval establishment considerably larger than the Cherbourg dockyard, where there is a floating basin 50 acres in extent. They will include three large docks each 500ft. in length, and nearly 100ft. clear, and two of about 400ft. in length, and 80ft. clear. The new docks will be formed on the south side of the large basin, with which they will communicate with locks, two locks also communicating with the largest basin. Each lock will be 85ft. clear, with a depth of water on the sills of 30ft., by which the *Warrior*, *Black Prince*, and other vessels of that class drawing 27ft. of water will be docked without having occasion to be lightened, an operation rendered necessary to all line-of-battle ships entering either of the existing docks, with the exception of Keyham. In the last, under certain circumstances, as much as 27ft. of water can be obtained at spring tides. The length of the largest basin at Chatham will be little short of 2000ft., with a breadth of 700ft., which will enable six of the largest line-of-battle ships to lie alongside each other at the quays, while under pressing circumstances double and even treble that number can be accommodated. The length of the second basin will be 1600ft., with a mean breadth of 700ft.; and that of the smallest basin 700ft., with a breadth of 430ft. Each basin will have 30ft. of water at neap tides. In order to obtain the necessary depth of water for ships of the largest size to ascend the Medway as far as Chatham dockyard—which from the numerous shoals allowed to accumulate in the river they are now unable to do—a complete system of dredging the river will be carried out. By this means the necessary depth of water will be obtained, while the navigation will be rendered less difficult by several of the sharp projections being removed, and a complete embankment of the river formed. Already the whole of St. Mary's Island, extending towards the Medway some two or three miles, has been embanked by means of convict labour, and this will be continued towards the estuary of the Medway. The river from the dockyard to Garrison Point, at Sheerness, a distance of about 12 miles, will be deepened to form a channel 600ft. wide, and 27ft. deep at half-tide, which will give 31ft. at neaps, and 35ft. at springs. At present the depth of water at low tide in Chatham Harbour is only about 17ft.

HARWICH HARBOUR.—The report of the select committee appointed to inquire as to the best means of preserving Harwich Harbour as a harbour of refuge was issued on the 17th ult. The committee, after alluding to the dangerous state of the harbour, recommend that a bill should be brought in by the Board of Trade, authorising the placing of the Stour, Harwich harbour, and such portions of the Orwell as are not under the dock commissioners of Ipswich, under the supervision of a conservancy board representing the various local interests of Harwich, Mistley, and Ipswich, in addition to certain members to be named by the Board of Trade. This conservancy board should have power to levy such dues on shipping using the harbour as may be necessary to defray the cost of improvement and maintenance, and provision should be made for the application of all dues raised on shipping to shipping purposes. As national interests are concerned in the proper maintenance of the harbour, some assistance, the committee think, should be given by the Government.

LIGHT DUTIES.—The light duties of 1861, amounted to £251,399 from over sea vessels, and £49,803, from coasting vessels. The sum is nearly the same as in 1860.

THE THAMES EMBANKMENT.—Petitions have been presented for consideration of the committee claiming special protection, from the London Chatham and Dover and Charing-cross railway companies. The first mentioned company set forth that a provision was inserted in their Metropolitan Extensions Act, to the effect that it was desirable that their bridge at Blackfriars should not interfere with the embankment of the Thames, and that they might construct and carry it on a level not higher than 37ft. above Trinity high-water mark, on receiving a notice to that effect from the Board of Trade, but no such notice had been received, and considerable expenditure had been incurred by the company in preliminary proceedings. The works intended to be constructed by the Thames embankment will, they allege, interfere with the construction of their railway and bridge in a manner beyond their parliamentary powers, and not being compatible with those portions of the line already constructed, will entail on them increased expenditure, and involve an entire change in their plans and arrangements. The Charing-cross railway company state that they are the owners of all the property known as Hungerford-market, including the Suspension-bridge, and have agreed to pay £55,000 to the market, and £85,000 to the bridge company for their right and interest, together with the wharfage dues, piers, and tolls; that the embankment will interfere with their central station at Charing-cross, and with the revenue to be derived from the tolls and dues, by the establishment in connection with the embankment of competing piers and landing-places. Objection is also taken by the London Chatham and Dover company to the powers sought for, to the compulsory purchase of lands required for their own undertaking.

MINES METALLURGY. &c.

COAL IN BORNEO.—At the annual meeting of the Labuan Coal Company, the chairman announced that the seams now being opened have been sufficiently tested to show that they can yield 100,000 tons of coal per annum for ten years, that the two pits necessary for this rate of extraction will be completed about October, and that the entire cost of raising will not be more than 6s. per ton. Eighty-five tons have already been supplied to her Majesty's steamer *Scout*, and fair quantities will be regularly raised while the pits are being sunk.

THE AMERICAN LAKE COPPER.—In 1846, the copper mines of Lake Superior yielded only £160 worth of copper. Last year they yielded copper worth £600,000.

GOLD IN COSTA RICA.—It is stated that a grant has been obtained from the local government for working some promising gold veins in Costa Rica, and that upwards of 60 pieces and cases of suitable machinery, manufactured by Mr. John Walker, of Cowper-street, City-road, were lately sent out by a mail steamer. The vein is a fine decomposed quartz, and if the bulk be half as rich as that which has been crushed in this country, large profits must be realised.

APPLIED CHEMISTRY.

DETERMINATION OF THE SPECIFIC GRAVITY OF MINERAL SUBSTANCES, BY DR. T. L. PHIPSON.—I make use of a very simple method for taking the specific gravity of minerals. It consists in measuring the volume of water displaced by a given weight of the substance experimented upon. I take a glass cylinder, graduated in cubic centimètres and fractions of cubic centimètres, and after pouring in some water the height of the latter in the cylinder is noted. A given weight of the mineral is then introduced, and when the air bubbles have disappeared. the height of the liquid is noted again. Now, a cubic centimère of water weighs a gramme; therefore, if, after the introduction of 5 grammes of mineral, I find the water has risen 2·5 cubic centimètres, $\frac{5}{2 \cdot 5}$ gives the specific gravity of the mineral. This method necessitates only one weighing.

HARBOURS OF REFUGE.—The annual return showing the progress of works and harbours of refuge has been issued. At Dover, where £500,000 has been laid out, and a vote of £50,000 is to be taken this year; to be followed by £100,000 more in future years, the length of the pier founded is now 1573ft., and 1390ft. have been completed to the quay level. The South Eastern Railway is now carried on to the pier. At Alderney, 1220 yards of sea wall and 1226 of harbour wall of the western breakwater are complete, except the coping, and the promenade wall is ready for the coping for a length of 1217 yards from the shore; the base of the breakwater extends 1636 yards from the shore. From 500 to 700 men are kept employed at this work, for which there has been voted £937,000, the total estimate being £1,300,000. Of the breakwater at Portland, which is to shelter 2130 acres of the bay, the centre of the north head is 8512ft. from the shore, and the depth of water 9½ fathoms at low water of spring tides. During the heavy gales of February and March, many vessels took refuge within this harbour, some from 600 to 1200 tons burden and from 110 to 120 vessels remained in harbour for some days. The votes already passed for the works at Portland amount to £973,000; the total estimate exceeds £1,000,000. Upwards of 5,000,000 tons of rough stone have beed deposited since the commencement of the work.

A QUICK AND EASY METHOD OF PREPARING SULPHATE OF CADMIUM.—This method, adopted by the author, is nothing more than the application of the fact observed in 1792 by Richter, that a metal plunged into a saline solution substitutes itself for the metal, which forms the base of the salt employed. A quantity of crystallised sulphate of copper, say 100 grammes, is dissolved in water, and a piece of cadmium, rather more than is necessary to saturate all the sulphuric acid, or in this case more than 44·59 grammes, is plunged into the solution. The whole having been allowed to stand for some time, the precipitated metallic copper is then separated by filtration and the liquid slowly evaporated. If, during evaporation, the neutral solution of sulphate of cadmium should deposit a small quantity of sesquioxide of iron, which not only constitutes an impurity, but gives the salt a bad appearance, it is necessary to expose the solution to the atmosphere until all the iron which it may contain has been eliminated, which is accomplished when, after a second filtration, the transparency of the solution is no longer disturbed. To obtain finally the sulphate of cadmium in well-formed cyrstals, it is necessary to acidulate the solution slightly with dilute sulphuric acid.

BICARBONATE OF AMMONIA.—Schrötter found a mass of crystals in a cast-iron pipe through which raw gas passed, which on analysis proved to have the composition $NH_4O,_2CO_2 + HO$. Before the analysis was made the crystals were cleaned from coal-tar with which they were soiled, and were resublimed. There is no doubt, then, of the existence of a true bicarbonate of ammonia.

OZONE.—In a letter to Professor Faraday, Schönbein writes:—"After many fruitless attempts at isolating ozone from an ozonide, I have at last succeeded in performing that exploit; and have also found out simple tests for distinguishing with the greatest ease ozone from its antipode, 'antozone.' As to the production of ozone by purely chemical means, the whole secret consists in dissolving pure manganate of potash in pure oil of vitriol, and introducing into the green solution pure peroxide of barium, when ozone, mixed with common oxygen, will make its appearance, as you may easily perceive by your nose and other tests. By means of the ozone so prepared, I have rapidly oxidized silver at the temperature of 20° C., and by inhaling it produced a capital 'catarrh.'"

ON THE PREPARATION OF OXALIC ETHER, BY M. KOLBE.—Mix 180 grains of oxalic acid, dried at 100°, with 100 grains of acid sulphate of potash, and submit them, in a retort, to the action of a temperature of 150° or 180° C. Then drop gradually into the tubulure of the retort a mixture of 250 grains of absolute alcohol and 25 grains of concentraced sulphuric acid; cohobate and distil at a temperature not below 150° C. After shaking up the product of the distillation with some water, dry over chloride of calcium and rectify. The product is about 70 per cent. of the quantity indicated by theory, basing it upon the quantity of oxalic acid used. By adding ammonia to the mother-waters, a considerable quantity of oxamide is also obtained.

REDUCTION OF SULPHURIC ACID BY NASCENT HYDROGEN, BY M. KOLBE.—It is an established fact that when sulphurous acid is reduced by nascent hydrogen sulphuretted hydrogen is produced. MM. Fordos and Gélis have founded upon this reaction a very simple process for recognising the presence of sulphurous acid; but it has hitherto been unknown that sulphuric itself, under these circumstances, undergoes a similar reduction. Hydrosulphuric gas, which always contaminates hydrogen prepared with zinc, water, and sulphuric acid, has probably no other origin. M. Kolbe has remarked that this gas is developed in increasing quantity proportioned to the degree of concentration and high temperature of the acid. This is not an unimportant phenomenon. It can be prevented by employing sulphuric acid previously diluted with twice its volume of water, in which case pure hydrogen is produced; but if concentrated acid is then poured into the mixture, hydrosulphuric gas speedily appears. This circumstance especially deserves attention when Marsh's apparatus is employed; in fact, under these circumstances, the sulphuretted hydrogen may convert the arsenious acid either wholly or partially into unalterable sulphide of arsenic, and thus, from the presumed absence of arsenic in the suspected matter, lead to a wrong conclusion.

POTABILISATION OF SEA-WATER BY THE ELECTRIC CURRENT.—An interesting paper by Dr. Phipson, entitled *Electricity at Work*, in which the author passes in review the useful applications of this wonderful agency, appeared in the late number of McMillan's Magazine. He concludes his paper as follows:—"Reflecting upon the powerful decomposing chemical force with which we are furnishrd by the electric current, it occurred to me that I might be able to render sea-water potable by decomposing and extracting its salt, by means of a moderately powerful battery. The experiments were made at Ostend a few years ago. My apparatus consisted of three vessels containing sea-water; the centre one contained the water to be operated up, the two others communicated with the two poles of the battery. The three vessels were connected by two bent ∩-tubes filled with sea-water. As the only battery I could procure in Ostend was rather weak, I passed the current through the water for about fourteen hours, after which one of the outside vessels had become acid and the other alkaline. The sea-watsr was then filtered through charcoal, and was nearly drinkable. It would have been, I doubt not, quite potable had the battery been more powerful, as it was I found it difficult to extract the last particles of salt; and the water, after subsequent trials, still presented a slightly brackish taste. I have not had an opportunity of repeating this experiment since, but from the results obtained, I think it probable that sea-water may be rendered potable by means of the electric current.

MEAN TEMPERATURE OF THE AIR.—M. Becquerel shows that there exists a vast difference between the temperature of the atmosphere close to the ground, and that measured at an altitude of 60 to 70 feet above it. The soil, its nature, colour, and the objects which cover it, all influence the temperature within the above limits. It had long been observed that vegetation varies according to height, and that certain plants which cannot be cultivated in the valleys, will thrive very well on the tops of the adjoining hills. Often, also, frost will injure the flower of the vine, and respect that of the almond tree close by, which grows at a higher altitude. The director of the Botanical Gardens at Montpelier, has oberved thatllaurel, fig, and olive trees die away in the lower parts of his garden, but are spared a few metres higher up, though in both cases protected by the same contrivances. M. Becquerel states that the mean temperature of the air at the "Jardin des Plants," during the year 1861, increased regularly from one metre to 33 metres above the soil, and this circumstance has prompted him to endeavour to fix the altitude of which the temperature represents the real average at a given spot. He has remarked the curious fact that at 6 a.m., all the year round, the temperature is the same at any altitude not exceeding 21 metres; 6 o'clock a.m. is, therefore, a critical period of the day, the temperature of which must stand in a certain relation to that of the month or year, and this relation he expresses by certain co-efficients, which vary according to the different seasons, and reach their maximum in summer, and their minimum in winter. These co-efficients and the mean temperature at 6 a.m., will determine the temperature of the air at a given hour and altitude.

APPLICATIONS FOR LETTERS PATENT.

We have this month adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated May 23rd, 1862.

1554 P. McGregor—Spinning and doubling cotton.
1555 R. Bracklidge—Sizing, dressing, or finishing warps, yarns, textile fabrics, or paper, and also thickening colours.
1556 C. DeBergue—Metal reeds for weaving.
1557 W. E Wiley—Penholders.
1558 J. Webster—Coating and indurating metals.
1559 J. Ward—Textile fabrics.
1560 E. Mouline—Weaving
1561 E. Maw—Ships, vessels, forts and batteries.
1562 A. Samuelson—Hydro static presses.
1563 W. Clark—Socks and stockings.

Dated May 26th, 1862.

1564 G. T. Livesay—Purifying gas.
1565 J. Harrison—Rollers for preparing, spinning, doubling, sizing, winding, warping and weaving.
1566 J. Harrison & Sons—Winding and weaving.
1567 C. De Bergue—Iron framing.
1568 C. Brakell, W. Hoehl, and W. Gunther—Steam and other motive engines.
1569 M. Wells and J. Crompton—Railway signals.
1570 J. Taylor—Apparatus for preparing cotton or other fibrous materials to be spun.
1571 W. Brierley and G. F. Smeeton—Targets.
1572 W. Clark—Fastening buttons to garments.
1573 W. Worby—Reaping machines.
1574 J. A. C. N. Delpech—Pumps.
1575 R. M. Letchford—Matches.
1576 G. A. Huddart—Superheating steam.
1577 J. E. Holmes—Machinery for digging or cultivating land.
1578 J. E. Holmes—Machinery for digging or cultivating land.
1579 J. E. Holmes—Printing machinery.
1580 T. D. T. Sparrow—Shading street lights.

Dated May 27th, 1862.

1581 E. Tuck—Electrical manipulation.
1582 C. A. M. Durand—Watermills.
1583 W. E. Gedge—Wire ropes or cables.
1584 J. Halliday—Ornamental trimmings.
1585 J. Ireland—Moulds for card cylinders
1586 H. D. P. Cunningham—Anchors.
1587 W. Clark—Brakes for railroad carriages.
1588 F. Tolhausen—Wire gauze, metallic, and asbetos tissues.
1589 G. H. Sanborn — Revolving breech-loading fire-arms.
1590 J. Hay—War ships, floating and land batteries or forts, mercantile and other vessels.
1591 J. Duffus—Measuring piece goods or webs.
1592 W. Palmer—Revolving fire-arms.
1593 D. T. Moss—Fastening horse shoes.
1594 G. H. Daw—Fire-arms.
1595 C. H. Hudson—A defensive armour.

Dated May 28th, 1862.

1596 H. Eaton—Presses for baling purposes.
1597 J. H. Kid—Waterproofing fabrics.
1598 J. Simpson—Mouldings.
1599 J. Rogerson—Iron floating dock.
1600 C. Cohen—Walking, umbrella, and other like sticks.
1601 J. F. Harrison—Preserving the bottom of ships.
1602 R. Martendale—Globes and glasses.
1603 T. Turner—Machinery for scouring and polishing knitting and other pins and needles.
1604 H. Saunders and J. H. Mills—Venetian and other blinds.
1605 J Hurst, jun., and E. Taylor—Evaporating water and other fluids.
1606 R. Brooman—Machinery for looped or knitted fabrics.
1607 J. Johnson—Tinned lead pipes.
1608 W. Blackmore and H. Lamb—Burning limestone and generating steam.
1609 J. Ransome—Fastening railway chairs with wood trenails.

Dated May 29th, 1962.

1610 J. Critchley—Rib fastener for umbrellas and parasols.
1611 J. Hirst, jun., and J. Wood — Stereoscopic apparatus.
1612 P. Boisset and B. Antoguini—Boots and shoes.
1613 H. Boetius—Cooling hot liquids, and condensing steam.
1614 G. Ashton—Dying fibrous substances.
1615 J. Denby and J. Crabtree—Looms for weaving.
1616 W. Perks—Metallic sash bars for windows, skylights, hot-hous s, and other like purposes.
1617 C. Abel—Raising, propelling, or exhausting air, water, or other fluids or gases.
1618 R. Griffiths—Propellers for ships and boats.
1619 J. Paterson—Hammer or instrument for turning over the edges of a binding or strip of linen or other material and preparing it for stitching in sewing machines.
1620 W. Clark—Throwing the shuttles of looms.
1621 N. Lawton and R. Whitworth—Engines for carding cotton and other fibrous materials.
1622 S. Minton—Revolving battery.

Dated May 30th, 1862.

1623 W. Footman — Sewage and liquid manures, and reservoirs and pipes to be used therein.
1624 F. Datichy and E. Sabatier — Pulp for the manufacture of paper and other purposes.
1625 P. U. Payras—System to protect all dry skins.
1626 J. Gurren—Domestic telegraphing.
1627 R. Nicholson—Lawn mowing machines.
1628 I. Leon—A stopping rein.
1629 J. Morrison — Springs for ladies' dresses or crinolines, and for chair, sofa, and other seatings, as well as for bedstead and couch sackings.
1630 C. Staunton—Signalling and indicating the position of shots on targets in rifle practice, and for preventing accidents to the markers.
1631 H. Burt—Protecting wooden posts from decay.
1632 R. Steed—Signalling on railways.
1633 T. Pengelly and W. Byron—Hoisting goods.
1634 W. Eddington, jun. — Draining and tilling land.
1635 R. Lofft—Small fire-arms and cartridges.
1636 J. Ives—Washing and wringing clothes.

Dated May 31st, 1862.

1637 A Gilbey—Packing cases for holding bottles
1638 J. Holland—Traction engines.
1639 G. Ermen and R. Smith—Machinery for spooling and balling sewing threads, silk, yarn, &c.
1640 W. Smallwood and W. Wright—Water closets.
1641 A. Moreaux and A. Ernest—Electro-magnetic machines.
1642 T. Vicomte de Veye—Protecting iron from rust.
1643 R Shortrede—Pressing cotton, &c.
1644 D. Lamb—Railway buffers.
1645 H. Watson and J. Millbourn—Pulp strainers or knotter bottoms.
1646 J. Betteley—Ship building, and rendering ships shot proof.
1647 I. Villa—Exhibiting terrestrial, and astronomical phenomena, and facilitating the solution of problems relating thereto, without the aid of calculation.
1648 T. Lawden—Single and double barrelled guns.
1649 G. Lingham and J. Nicklin—Crinoline connector and suspender.
1650 L Chaubart—Raising the level of water in rivers, canals, &c.
1651 W. Newton—Rendering cloth, leather, &c. impermeable to water and other fluids.
1652 W. Sullivan—Preservation of stone, plaster, cement, &c.
1653 W. Newton—Shot proof gun towers.

Dated June 2nd, 1862.

1654 B. Templar—Registering and indicating billiards and other games.
1655 J. King and J. Partington—Looms.
1656 J. Elce and W. Gradwell — Machinery for spinning, doubling, and winding cotton.
1657 A. Sax—Kettle, big, or other drums.
1658 T. Campbell—Witneying piled fabrics.
1659 Carl Reckner—Coffer dams.
1660 J. Baker—Pumps.
1661 J. Key and F. Potts—Designs in iron, and application of same to metal articles of furniture.
1662 C. Gray — Extracting, rendering, receiving, purifying, cooling down, and delivering oleaginous and fatty matters.
1663 J. Whitworth—Shells.
1664 W. Newton—Handles of shovels, spades, dung forks, and other analogous articles.
1665 E. Lloyd—Manufacture of paper.
1666 A. Newton—Breaking and cleaning flax.
1667 J. Marson — Projectile for small arms and ordnance of every description.
1668 J. Gebhardt—Fastening for bags, purses, &c.

Dated June 3rd, 1862.

1669 T. Scowen—Ocular demonstrator of time in music and accentor.
1670 G. Gurney—Artificial light.
1671 W. Hall—Miners' safety lamps.
1672 R. Kemp—Harmoniums.
1673 J. Biers—Shoes for horses and other animals.
1674 S. Weston—Trusses.
1675 J. Norton—Machinery for raising and forcing water.
1676 J. Fincham—Repairing of roads and ways.

Dated June 4th, 1862.

1677 A. Perry—Securing railway chairs and sleepers.
1678 G. Peel, jun.—Hydraulic presses and force pumps.
1679 C Cathill—Felted fabrics.
1680 W. James — Bolts, spikes, and nails, and apparatus for their manufacture.
1681 T. Alcock—Horse rakes.
1682 R. Roe—Planes for tongueing working sash fillisters.
1683 G. Allibon and E. Snell—Surface condensers and superheaters.
1684 G. Toselli—Freezing and cooling liquids.
1685 I. and G. Battinson—Combing wool.
1686 G. Sanborn—Refrigerators.
1687 P. Freston and C. Goodman—Permanent way of railways
1688 E. Scheutz—Rotatory engines.
1689 S. Huston—Safety valves.
1690 A. Newton—Grain and grass harvesters.
1691 E. Conroy—Cutting corks, bungs, and such like articles.

Dated June 5th, 1862.

1692 G. Rydill—Hydraulic pump or engine for raising liquids and obtaining motive power.
1693 J. Moiroux—Protecting and preserving the polish of metals, woods, skins, and papers, and for rendering all woven, textile, and other fabrics water and weather proof.
1694 J. Bell—Fastenings for railway chairs.
1695 R. Robinson—Fire escapes.
1696 J. and J. Stanley—Stoves or apparatus for diffusing heat.
1697 J. Heatley—Lifting jacks.
1698 R. Sill—Attaching direction cards, name plates, or other cards or plates to trunks.
1699 P. Parsons—Ordnance, and tools for rifling the same.
1700. W. Rowe—Forge and bellows.
1701 E. Conroy—Machinery for cutting corks, bungs, and such like articles.
1702 G. Hadfield—Casks or barrels.
1703 W. Newton—Organs and wind instruments.

Dated June 6th, 1862.

1704 J. Verity—Coating and preserving walls.
1705 E. Death—Road locomotives or traction engines.
1706 G. Darlinson—Manufacture of ribbons.
1707 W. Jeune—Manufacture of fabrics suitable to be used as substitutes for solid leather.
1708 A. Newton—Knitting machinery.

Dated June 7th, 1862

1709 W. Harding—Bonnet fronts.
1710 A. Adams—Fire-arms.
1711 G Hatton—Presses.
1712 G. Haseltine—Photograph Camera.
1713 C. Hook—Steam engines.

Dated June 8th, 1862.

1714 J. Lovegrove—Apparatus for inspecting small sewers and drains.
1715 W. Turner—Engines for carding cotton. &c.
1716 A. Ford—Protecting beer and other fluids from the direct action of atmospheric air.
1717 E. Hottin—Preventing stuffs and wood-work from igniting.
1718 J. Keeling—Manufacture of gas.
1719 J. Ryo-Catteau—Machinery for twisting wool, cotton, flax, silk, and other fibrous threads.
1720 C. Heckethorn—Apparatus for obtaining and applying motive power.
1721 F. Ginchosa—Ventilating mines, ships' holds and other places.
1722 A. Joyce—Lighting and heating.
1723 A. Knowles—Washing extracted wool, &c.

Dated June 10th, 1862.

1724 W. Smith—Photography.
1725 T. Lister—Material as applied for address-cards, &c., whether for printing or writing upon.
1726 J. Kinlock—Looms for weaving.
1727 J. Pols—Method of refining oils.
1728 N. Davis—Propelling ships.
1729 G. Jourdain—Treating cocoa-nut oil.
1730 H. Jennings—Preparation of skins for driving bands and harness traces.
1731 J. Alison—Harrows.
1732 J. Ingle—Reaping and mowing machines.
1733 J. Appold—Regulating the discharge of water and other liquids, and air and other gases.

Dated June 11th, 1862.

1734 J. Shand—Construction of steam boilers.
1735 W. Lennan—Safety stirrup.
1736 J. Wake—Construction of ships and vessels.
1737 H. Bland—Sewing machines.
1738 W. Holland—Carding machines.
1739 W. Crook—Looms for weaving.
1740 D. Crichton, W. Donbavand. and D. Crichton—Looms for weaving.
1741 J. Marsh—Manufacture of lace
1742 J. Johnson—Cradles or swing cots.
1743 B. Gerland—Manufacture of sulphate of copper.
1744. J. Holmes—Cultivating or harrowing land.
1745 J. Hetherington—Lubricating revolving surfaces.

Dated June 12th, 1862.

1746 J. Ingram and W. Wood—Preparing colouring matters for dyeing and printing.
1747 I. Spight—Horse hoes.
1748 F. Tolhausen—Surgical injecting apparatus.
1749 A. Lerenard—Cement or mastic for making joints in steam or water pipes.
1750 H. Firman and W. Williams—Apparatus for cutting up and preparing as food or chaff for animals, or for any other purpose, straw, hay, &c.
1751 H. Firman and W. Williams—Lamps.
1752 A. Salviati—Producing indestructible inscriptions and ornamental surfaces in gold, &c.
1753 B. George—Portable beds, bolster, pillows, &c.
1754 M. Jackson—Shield for the gums, to protect them from injury when cleaning the teeth.

Dated June 13th, 1862.

1755 W. Smith—Cutting or dividing scap.
1756 G. Haseltine—Rails for railways.
1757 A. Longbottom—Artificial stone.
1758 J. Wilson—Ships for war purposes, applicable also to mercantile marine.
1759 J. Glew—Sewing machines.
1760 C. Tyler—Holder for holding dinner and other plates and dishes.
1761 T. Fleming—Preparing charges for fire-arms.
1762 J. Bermingham — Construction of vessels of war, also applicable to commercial vessels.
1763 W. Newton—Fire-arms and the attachment of bayonets or swords thereto.
1764 W. Newton—Elongated bullets.
1765 J. Ives—Expressing juice from fruit, &c.
1766 J. Robinson—Sawing wood.

Dated June 14th, 1862.

1767 J. Lancelott—Ornamental chains from sheet metal.
1768 T. Williams and Henry Cox—Churns.
1769 J. Sawyer and G. Padgham—Steam boiler and other furnaces.
1770 J. Ballott—Portable circular saw.
1771 J. Miguel—A system of pessary.
1772 J. Johnson—Jacquard machines.
1773 W. Bouch—Cranes.
1774 R. Brooman—Coking ovens.
1775 W. Wighton—Regulating watches and other time keepers.
1776 R. Hicks—Preparation of paints, pigments, and colours
1777 C. Edme Courtillier—Inhaling and saturating apparatus.

Dated June 16th, 1862.

1778 F. Lanoa—Geodetic and topographic instrument, to replace every one used in surveying.
1779 J. Allan—Furnace arrangements to prevent smoke and economise fuel.
1780 G. Birkbeck—Presses for extracting liquids from various substances.
1781 J. Evans—Self acting mules.
1782 W. Curtis—Screw propellers.
1783 H. Bright—Screening fires in stoves and grates.

Dated June 17th, 1862.

1784 J. Holmes—Digging or cultivating land.
1785 S. Huntly—Furnaces for effecting the more perfect combustion of the fuel.
1786 A. Crestadoro—Utilizing a certain well-known agent as a power to drive machinery.
1787 J. Hunt—Bronzing or colouring copper articles.
1788 W. Sinnock—Compound fabrics.
1789 A. Makinson—Locomotive and other engines.
1790 J. Nield—Manufacturing pipes of cast iron.
1791 A. Pringle—Locks.
1792 M. Turner—Small arms and ordnance.
1793 S. Varley—Reaping machines.
1794 W. Clark—Buttons.
1795 G. Haseltine—Roofs for railway cars, &c.
1796 J. Kellow and H. Short—Blasting powder.

Dated June 18th, 1862.

1797 J. Wheater—Mules for spinning cotton.
1798 J. Johnson—Projectiles.
1799 J. Warren—Ploughs.
1800 F Coltman—Apparatus for discharging coal.
1801 W. Newton—Electrical brushes.

Dated June 19th, 1862.

1802 W. Clark—Manufacture of boxes.
1803 J. Smith—Universal fire alarum, with discharging apparatus.
1804 G. Speight—Head ornaments.
1805 A. Howat—Water gauges and blow-off taps for steam boilers.
1806 H. Rushton—Machines to plait cotton yarns.
1807 W. Stokes, C, James, J. Stokes—Machinery for stocking and screwing guns and pistols.
1808 R. Stansfield—Looms for weaving.
1809 C. Cartwright—Stopping or retarding trains on railways.
1810 M. Wiggell—Form of bolts and other fastenings for shipbuilding.
1811 E. Davis—Preparing food for horses.
1812 J. Wood—Driving straps or bands, the backs of wire cards and cop tubes.
1813 W. Thomson—Machinery for making bricks.

Dated June 20th, 1862.

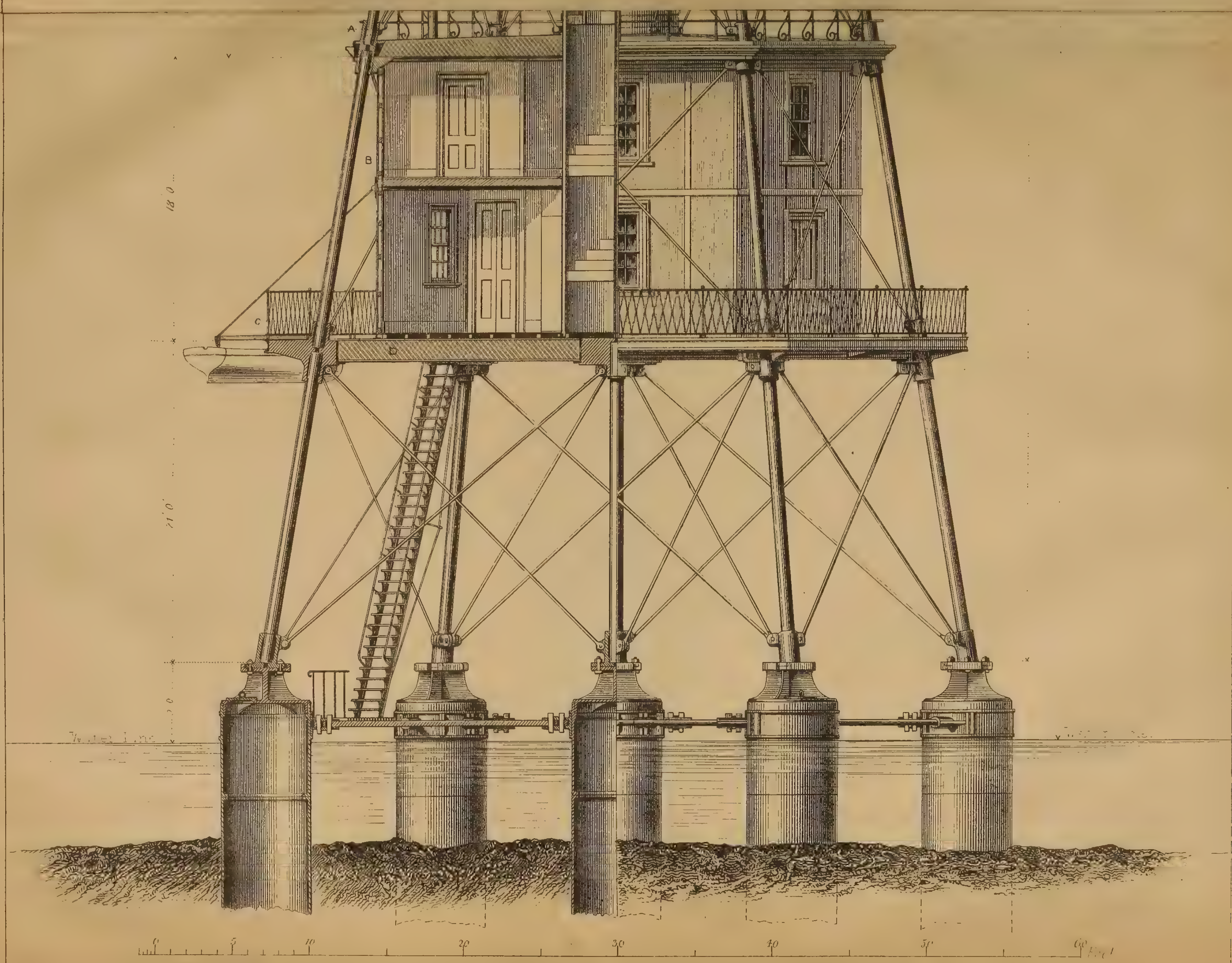
1814 W. Jefferies—Rails for railways, and a new or improved chair or sleeper for the said rail.
1815 J. Dupuch—Cocks for regulating the supply of gas.
1816 J. Detuncq—Machine for treating flax or hemp.
1817 W. Gedge—Candlesticks, and machinery used in their manufacture.
1818 J. Bedford—Plane iron, cut iron, or double iron, and especially for the method of manufacturing plane irons and other tools by punching, flying, or stamping by dies.
1819 W. Malins—Protective covering for agricultural purposes.
1820 D. Adamson—Steam boilers.
1821 B. Mody—Varnish or polish.
1822 J. Taylor—Valves, and means for regulating and indicating the flow and pressure of fluids.
1823 D. Middleton—Cranes for lifting weights into and out of carts.
1824 C. Osman—Elastic or yielding surfaces for sitting, lying, or reclining upon.
1825 A. Warner—Pigments or paints from certain refuse materials.
1826 G. Gray—New material to be used as a substitute for the blackening or other materials employed in casting or moulding metals.

Dated June 21st, 1862.

1827 B. Fabbricotti—Polishing or grinding belt.
1828 F. Schneider and J. Snider — Breech-loading fire arms.
1829 G. Yapp—Various colours and tints of chromo-lithographic impressions on glass, earthenware, china, and other bodies.
1830 James Taylor—Doffer or stripper for carding engines for preparing cotton.
1831 G. Simpson—Machinery for working, boring, and mining or excavating tools, and mine and other pumps.
1832 H. Davenport and J. Davenport—Apparatus for loom healds or harness.
1833 J. Anderton—Tape-leg or sizing machine.
1834 S. Hosman—Pumps and valves.
1835 H. Gonnon—Machinery for making bricks.
1836 A. Maigron—Winding off, carding, and spinning all thready fabrics.
1837 J. Redstone—Boilers of steam engines.
1838 F. Tolhausen—Preventing collisions on railways.
1839 G. Bousfield—Steam engine valves.
1840 J. Lawson—Carpets and other piled fabrics.
1841 E. Edmonds—Felted articles and fabrics.

Dated June 23rd, 1862.

1842 T. Wilson—Dress fastening.
1843 H. McKenzie and P. Ramsay—Cylindrical or circular brushes or rollers for various manufacturing machines.
1844 H. Ponsonby—Topsail sheet bits or bolts.
1845 G. Haseltine—Machinery for mowing and reaping, the driving gear employed therein.
1846 A. Webster—Machinery or apparatus for boring slate.
1847 W. Barr—Manufacture of raised or brocaded fabrics woven in cotton or flax.
1848 R. Cook—Construction of pianoforte actions.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B
C
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18 0
21 0
Water Line
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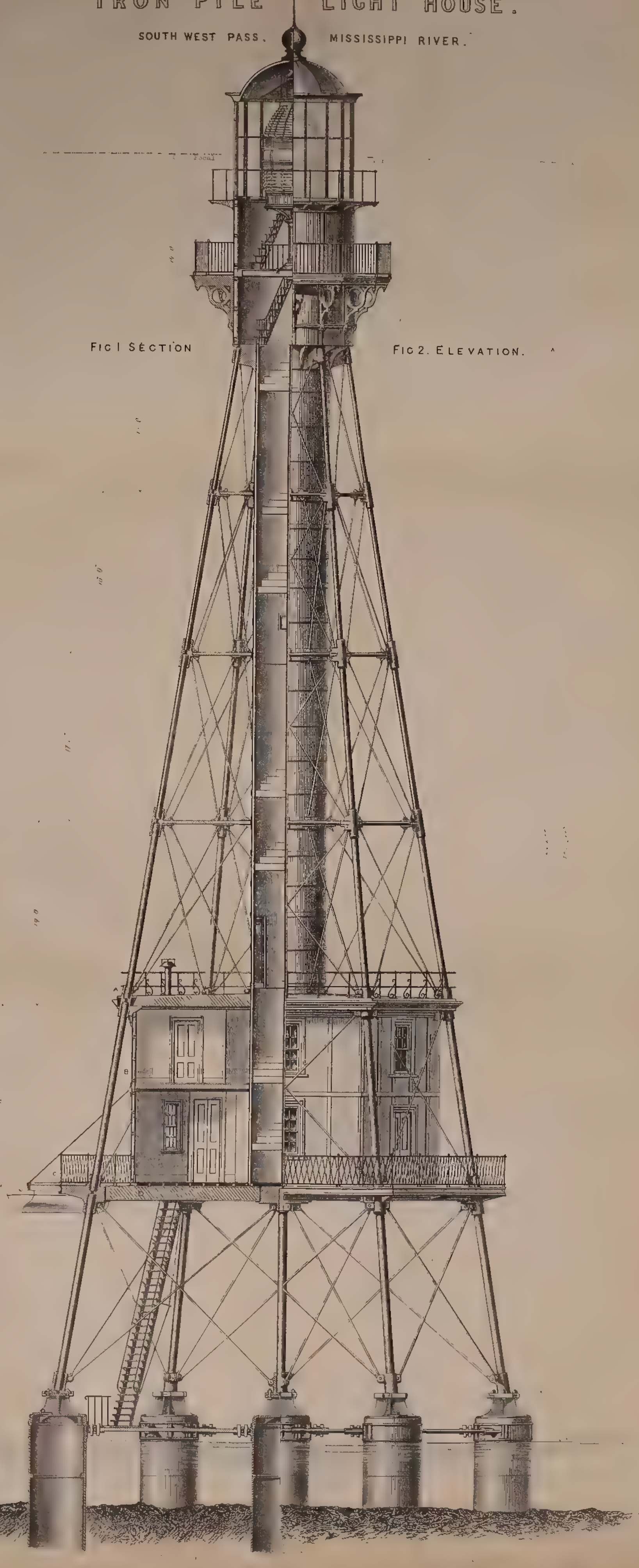
60

AMERICAN
IRON PILE LIGHT HOUSE.

SOUTH WEST PASS, MISSISSIPPI RIVER.



THE ARTIZAN.

No. 236.—Vol. 20.—AUGUST 1, 1862.

AMERICAN PILE LIGHT-HOUSE FOR THE SOUTH-WEST PASS OF THE MISSISSIPPI RIVER.

(Illustrated by Plate 219.)

In The Artizan of December last we presented our readers with a copper-plate engraving (Plate 204) of an American lighthouse upon the screw-pile system, accompanied with a copy of the specification upon which tenders were invited. We now give an illustration (Plate 219) of a different class of American lighthouses.

The foundation of the structure, consists of seven hollow piles, placed at the centre and corners of a hexagon; from these the superstructure rises in the form of a truncated pyramid, and is surmounted with a lantern containing a first order catadioptric lens.

The principal dimensions of the structure are as follows :—

The diameter of the base, or the distance from centre to centre of the hollow piles, taken across the corners, is 45ft.

The diameter at the top of pyramid, or the distance between the axes of the inclined columns where they intersect the upper side of the watch-room floor, is 11ft.

The horizontal plane passing through the intersections of the axes of foundation piles and inclined columns is referred to as the "base of pyramid."

The vertical distance from this plane to what is termed the top of the pyramid, or the upper side of the watch-room floor, is 106ft.

From the top of pyramid to the focal plane, the vertical height is 19ft. From the base of pyramid to the upper side of the girders of first floor, 21ft. From the upper side of first floor girders to the under side of roof girders, 18ft. The diameter of dwelling, taken across the corners and outside of the plating, is 31ft. The outside diameter of the cylinder containing the main stairway is 7ft., exclusive of the battens.

The outside diameter of the watch room and lantern (exclusive of battens) is 12ft. The foundation tubes or piles are of cast iron.

We very much regret to learn that amongst the other sad and ruinous events incident to the present struggle in America has been the destruction of a great many of the lighthouses on the American sea-board.

We may at some future time return to the subject of these lighthouses as there are several matters of detail in their construction which are deserving of notice.

USEFUL NOTES AND FORMULÆ FOR ENGINEERS.

(Continued from page 148.)

In the foregoing sections of this treatise, we have given means of reducing the various strains to which structures are subject to direct strains, either in tension or compression.

In the present section we purpose investigating the resistance of materials to the various strains, and affording the co-efficients of stress, for the various descriptions of strain.

That strain which tends to shear or cut the materials transversely has not yet been treated of, because of its extreme simplicity, thus it is evident, that the greatest shearing strain on a girder is that produced by the reaction of the supports, and the least shearing strain is at the point of the maximum horizontal strain, where it is nothing, and from which it increases to the maximum, in direct ratio to the distance from the point of greatest horizontal strain; let w represent the load per lineal foot on a girder, and let it be required to find the shearing strain at a point distant x feet from the point of greatest horizontal strain; then, if

S = the shearing strain,

$$S = w\,x$$

The resistance to torsion or twisting is called unit operation, in all kinds of shafts for driving machinery, in drills, boring bars, &c.

Friction adds something to the resistance of rivetted plates; but as this kind of efficiency may vary very considerably according to circumstances, and is also liable to deterioration, we shall not lay down any rules for estimating it. The co-efficients of safety will supply information as regards the stress which may be safely applied in practice.

Resistance to Tearing.

If a cylindrical or prismatic bar, whose sectional area is a, is subject to a pull whose resultant acts along the axis of the bar, and whose amount is W, the intensity of the strain, or the strain per unit of section will be

$$= \frac{W}{a}$$

The first effect of this stress is to produce an extension of the bar, and if this extension does not exceed the limit of elasticity the bar will recover its original form and size when the load W is removed; if the elongation proceeds beyond the limit of elasticity, a permanent set is produced and the strength of the material is deteriorated; and lastly, rupture of the bar is effected, the weight which produces it is termed the breaking weight, and is usually taken at per square inch of sectional area.

A sudden pull on a bar produces twice the strain that the same weight will effect when applied gradually, as the work performed by the constant force $\frac{W}{2}$ acting through a given space, is the same with the work performed through the same space by a force increasing at an uniform rate, from O to W.

Tensile resistance is also that which vessels subject to interior pressure oppose, such as water pipes, boilers, &c., the formula previously given will apply to water pipes and other cylindrical vessels.

Let S = tensile strain per sectional square inch.
r = radius internal.
p = internal pressure per square inch.
t = thickness of the material in inches.

then,

$$S = \frac{p\,r}{t}$$

For spherical vessels we have, if

W = total force.
A = sectional area.
$\pi = 3{\cdot}14159$, &c.

$$W = p\,\pi\,r^2,\ A = 2\,\pi\,r\,t$$

$$S = \frac{W}{A} = \frac{p\,r}{2\,t}$$

hence, spherical vessels are twice as strong as cylindrical ones.

The last equation will also give the longitudinal strain upon a cylindrical vessel; but as this is only half the circumferential strain it is not taken into consideration in practice. It may be here observed that a sphere is the form best suited to resist internal pressure, as it has a maximum content, with a minimum surface, and if other forms are used it is found necessary to stay them internally with tie bars; cylindrical boilers only require the ends to be stayed, but square boilers require staying in all directions, and even then are not safe for very high pressures.

Resistance to Crushing.

We shall obtain the intensity of crushing stress by the same formula as is used for the tensile stress. The resistance to compression is exactly similar to that for tension so long as the results of bending or buckling are not produced, and the formula for tensile strains will apply to compressive strains, in the absence of these results; thus the formulæ given (p.) may be applied to cast-iron columns, whose lengths are small compared with their diameters; also to cast-iron pipes, condensers, air-pumps, &c., subject to external pressure, but they do not hold good for less rigid materials, such as wrought-iron.

The resistance to compression which is offered in bridge girders, &c., may be considered as unaffected by bending, &c., provided that they are well braced and of a rigid form.

We shall now proceed to consider the resistances opposed to compressive strains by long columns, and by their tubes.

Resistance of Pillars to Crushing.

Columns usually break, not by the direct crushing force, but by bending, which subjects them to strains similar to those produced by transverse stress, and generally rupture commences by fragments splitting off from the compressed side of the column.

Very short columns break by an oblique shearing action, or the sliding of one part over another, and occasionally two cones or wedges are formed which, being forced together, split and drive outwards the parts surrounding them.

We now proceed to the case where crushing takes place by bending.

Let W = the load acting on a long pillar or strut,
A = its sectional area,

then one part of the intensity of the greatest stress is

$$p' = \frac{W}{A}, \text{ where}$$

p' equal the stress per sectional unit.

Another part of the greatest stress is that which arises from lateral bending, and which will occur in that direction in which the pillar is most feasible, that is to say in the direction of its last diameter, if the diameters are unequal.

Let d be that diameter, d_1 the diameter at right angles to it, let l be the length of the pillar, and v be the greatest deflection.

Then the moment of flexure—

$$= W v$$

the greatest stress produced by that moment is directly as the moment and inversely as the breadth and square of the thickness, if,

$$p'' = c \times \frac{W v}{d_1 d^2}$$

where c is a constant to be determined by experiment.

But the greatest deflection consistent with safety, is directly as the square of the length, and inversely as the thickness, and $d_1 d^2$ is proportional to the sectional area s, and to the thickness d_1; consequently.

$$p'' = c \times \frac{W l^2}{S d^2} = c \times p' \times \frac{l^2}{d^2}$$

and the whole intensity of the greatest stress on the material being made equal to a co-efficient of strength f, is expressed by the equation—

$$f = p' + p'' = \frac{W}{S}\left(1 + c \times \frac{l^2}{d^2}\right)$$

and the strength of the pillar is expressed by

$$\therefore W = \frac{f S}{1 + c \times \frac{l^2}{d^2}}$$

A pillar rounded at both ends is of the same strength as a pillar of the same diameter, and twice the length; therefore, for this column, we have

$$W = \frac{f S}{1 + 4 c \times \frac{l^2}{d^2}}$$

A pillar fixed at one end and rounded at the other is a mean between the strengths of two similar pillars—one fixed at both ends and the other rounded at both ends. The following are the values of c and f, computed by Mr. Gordon, from Mr. Hodgkinson's experiments on pillars with flat capitals and bases. These values give the ultimate strength of the pillar.

	f lbs. per inch.	c
Wrought Iron	36,000	$\frac{1}{3000}$
Cast Iron	80,000	$\frac{1}{400}$

We will now consider Mr. Hodgkinson's formula, which being deduced from actual experiment, are, perhaps, the most valuable. The results of the experiments are:—

1. That in all long pillars of the same dimensions, the resistance to fracture by flexure is about three times greater when the ends of the pillar are flat than when they are round.

2. The strength of a pillar with one end round and one flat is an arithmetical mean, between the strengths of pillars with both ends flat, and rounded. Thus, of three cylindrical pillars, all of the same length and diameter; the first having flat ends, the second one end flat, and one round, and the third with both ends round, the strengths are nearly as 3, 2, and 1.

3. The strength of a pillar is increased about one-eight by enlarging its diameter in the middle.

4. The index of the power of the diameter, to which the strength of long pillars of cast iron with rounded ends is proportional, is 3·76 and 3·55 in those with flat ends; or the strength of both may be taken as following the 3·6 power of the diameter.

5. The strength of cast iron pillars is inversely proportional to the 1·7 power of the length. Thus the strength of a solid pillar of that material varies as,

$$\frac{d^{3\cdot6}}{l^{1\cdot7}}$$

where d represents the diameter and l the length of the column. If d is in inches, and l in feet, for columns with flat ends.

$$\text{Strength in tons} = 44\cdot16 \times \frac{d^{3\cdot6}}{l^{1\cdot7}}$$

For columns with rounded ends,

$$\text{Strength in tons} = 14\cdot9 \times \frac{d^{3\cdot6}}{l^{1\cdot7}}$$

For hollow columns, of which

D = external, and
d = internal diameter,

For those with flat ends,

$$\text{Strength in tons} = 44\cdot3 \times \frac{D^{3\cdot6} - d^{3\cdot6}}{l^{1\cdot7}}$$

For those with round ends,

$$\text{Strength in tons} = 13 \times \frac{D^{3\cdot6} - d^{3\cdot6}}{l^{1\cdot7}}$$

Strength of Short Flexible Pillars.

The above formula apply to all pillars whose length exceeds thirty times the diameter; for pillars shorter than this it will be necessary to modify the formula, since in these shorter pillars the breaking weight is a considerable proportion of that necessary to crush the pillar.

When the pressure necessary to break the pillar is very small, on account of the greatness of its length compared with its lateral dimensions, then the strength of the whole transverse section will be employed to resist flexure; when the breaking weight is half what is required to crush the material, one-half the strength may be considered as available for resistance to flexure; when the breaking weight is half what is required to crush the material, one-half the strength may be considered as available for resistance to flexure, the other half being employed to resist crushing; and, when, through shortness of the pillar, the breaking weight is very nearly equal to the crushing force, we may consider that no part of the strength is applied to resist flexure.

We may separate these effects by taking in imagination from the pillar by reducing its breadth as much as would support the pressure, and consider the remainder as resistance flexure to the degree indicated by the previous rules.

Let c be the force that would crush the pillar without pressure; d the pressure which would break it by flexure alone; b the breaking weight as calculated for long pillars; y the real breaking weight.

If we suppose a part of the pillar equal what would be crushed by the pressure d, taken away, we have, $c - d$ = crushing weight of the remaining part, and $y - d$ the weight actually laid upon it, whence

$$\frac{y - d}{c - d} =$$

the part of this remaining portion which has to resist crushing,

$$\therefore 1 - \frac{y - d}{c - d} = \frac{c - y}{c - d} =$$

the part to sustain flexure.

But the strength of the pillar, if rectangular, may be supposed to be reduced by reducing either the breadth of the computed strength, to the degree indicated by the last fraction. In circular pillars this mode is not strictly applicable, but we obtain a near approximation to the breaking weight y, by reducing the calculated breaking weight c in that proportion

Whence

$$b \times \frac{c - y}{c - d} = y,$$

the strength of a short flexible pillar b, being that of a long one,

$$\therefore b c - b y = c y - d y, \text{ and}$$

$$y = \frac{b c}{b + c - d}$$

In columns whose length is less than thirty times their diameter, with flat ends there was noticed a falling off of strength due probably to incipient crushing, and the weight which produced this incipient crushing was about a quarter of the crushing weight. It is, therefore, assumed that the greatest load to which a column may be subject, without injury by crushing, is a quarter the crushing weight, when the length of that column is about thirty times the diameter.

We shall have therefore $d = \frac{1}{4}$ in the preceding formula, whence in cast iron of the kind used in the experiments (Low Moor. No. 3.)

$$y = \frac{b\,c}{b + \frac{3\,c}{4}}$$

The experiments on the absolute crushing strength of iron from which to determine the value of c, gave as the mean strength of one square inch section.

109,801 lbs. = 49·018 tons.

ON THE CONSTRUCTION OF IRON ROOFS.

By Mr. J. J. Birckel.

The rapid introduction of iron in place of wood in the construction of roofs, will, we believe, cause our readers to consider the study of the construction of iron roofs as being worthy of their careful attention, and the interest with which they will peruse the subject will, no doubt, be greatly enhanced when we shall point out its bearings upon the security of human life and property.

In order to give our readers a clear insight into this subject, we will first deal with the theoretical questions which it embraces; and, divesting these of all unnecessary scientific difficulties, enable them to learn what should be done in any given case. We shall afterwards lay before them different existing examples of roofs, which will enable them to see what has been done under various circumstances, and which may serve to them as guides in their own future practice.

A roof is, generally, a series of trussed frames, so constructed as that their shape shall not be able to alter; and which, for the convenience of calculation, are supposed to be under the influence of vertical parallel pressures, some of which are permanent, and some casual. The permanent pressures are the weight of the structure of the roof, including frames and covering, and the casual pressures are those of wind, hail, snow, or rain, against all of which provision should be made. For the sequel, we shall see what are their respective amounts as generally admitted.

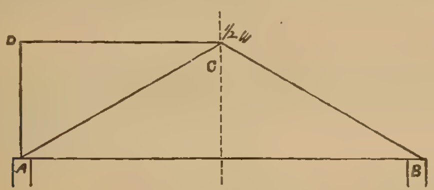


Fig. 1.

Fig. 1 represents the simplest kind of truss to be met with in roofs of small spans, and consisting of two struts A C, B C, called rafters, and of a tie rod A B; the frame as a whole is called a principal. Let W represent the whole load on one division of the roof, extending between two consecutive principals, the weight on each rafter will be $\frac{1}{2}$ W, and may be supposed to be collected at the points A and C, B and C, so that the weight directly supported at the points A and B is $\frac{1}{4}$ W, and at the point C $\frac{1}{2}$ W; this latter portion is transmitted in equal amounts to the walls or supports, which accordingly sustain each a pressure of $\frac{1}{2}$ W. With the assistance of the theory of parallel projections, so fully illustrated by Professor Rankine, it will now be easy to define the stress on each component part of the principal; for if A D be made to represent $\frac{1}{4}$ W, A C will represent the thrust upon the rafter, and D C the pull upon the tie rod, whence the following:—

In the case of a principal, constructed in the shape of a simple triangular truss, if the rise of the roof be made to represent one-fourth the load on one division of the roof, the thrust on the rafter will be represented by its own length, and the pull on the tie rod by one-half its own length.

This, to be sure, is simple enough; and when we remember that the load on the roof is an assumed one, we may safely say that the results thus obtained are quite as correct as those obtained by means of trigonometric calculations. But, if we must have trigonometric formulæ, we would prefer to have them in a shape which would enable us to solve them by simple reference to a table of sines and tangents; for, as homely practitioners, we are not likely to have at our fingers' ends all the transformations which trigonometric formulæ admit of; and, while we have to search in a treatise on trigonometry, we might be usefully employed solving the practical problem upon which we are engaged. The formulæ for the case under the consideration, as given by Professor Rankine in his *Treatise on Practical Mechanics*, are as follows:—Let H be the pull on the tie rod, R the thrust on the rafter, and i the angle, which the latter makes with the horizon, then—

$$H = \frac{1}{4}\frac{W}{\text{tang. } i}$$

and

$$R = \frac{1}{4}\,W \text{ cosec. } i$$

Here we have no difficulty in dealing with the first formula; for we find tang. i or log. tang. i in any trigonometic table; but cosec. i is generally ignored by those tables; and before we can solve the second formula, we must find out what relation cosec. i bears to sin. i, to cos. i, or to tang. i. On that ground, we would prefer Moseley's formulæ—

$$R = \frac{1}{4}\,\frac{W}{\text{sin. } i}$$

which is, indeed, its natural and legitimate form. General Morin, who devotes a considerable space to the subject of construction of roofs in his work on resistance of materials, gives two different values to the pull H on the tie rod. Looking, first, upon the rafter as an isolated beam, subject to the action of an equally distributed load in its length, and at its lower end to the reactions of the wall and of the tie rod, he arrives at the value of H, by imposing upon himself the condition that the deflection of the rafter shall be null, and thus obtains the formula—

$$H = \frac{1}{2}\,W.\,\frac{5}{8}\text{ tang. compl. } i = \frac{5}{16}\frac{W}{\text{tang. } i}$$

In a subsequent article on the same subject, proceeding to determine the value of H, by a method similar to Rankine's method of section, he finds,

$$H = \frac{1}{4}\,\frac{W}{\text{tang. } i}$$

which formula is identical with the one quoted in the first instance. Here then, there is a difference of $\frac{1}{16}$ in the values of H given by General Morin; and as we can detect no errors of calculus, we must look for the origin of that difference; we think, in that previous part of his work, in which he deals with the absolute deflection of beams, the formulæ there obtained being here made use of. As the difference is one of excess, however, we have no occasion to quarrel with this author about it, but have pointed it out rather for the purpose of showing that elaborate algebraic calculations may lead to results quite as much at variance with each other as plain geometric manipulations.

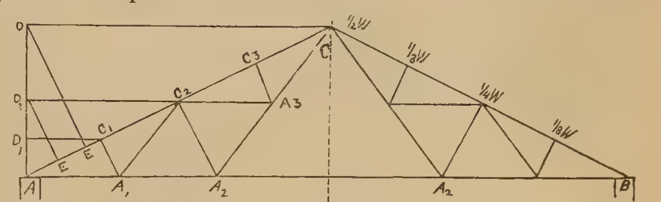


Fig. 2.

Fig. 2 represents a system of trussing which occurs frequently in iron roofs of large spans. A B C is the primary truss, consisting of the rafters A C, B C, and of the tie rod A B. The rafter is supported in its centre by a secondary truss A C A_2, consisting of the rafter itself, of the two ties A A_2, C A_2, and of the strut C_2 A_2; at the intermediate points C_1, C_3, it is supported also by two minor secondary trusses A C_2 A_1 and C C_2 A_3, similar to the one just described and supported by it. The stresses sustained by the component parts of each individual truss must be determined as if that truss was an independent structure; and to be able to do that we must see how the load is distributed upon the points A, C_1, C_2, C_3, C, which will be arrived at in the following manner: $\frac{1}{2}$ W being equally distributed upon each rafter, the load directly supported at the points C_1, C_2, C_3, is $\frac{1}{8}$ W, and the load at each point A and B is $\frac{1}{16}$ W; but the minor secondary trusses, through their tension rods, exert a pressure of $\frac{1}{8}$ W, at the point C_2, and of $\frac{1}{16}$ W at each of the points A and B; the major secondary truss exerts a pressure of $\frac{1}{8}$ W at each of the points A and B also, so that the final distribution of the load is, at C $\frac{1}{2}$ W, at each of the points A, B and C_2 $\frac{1}{4}$ W, and at the points C_3 $\frac{1}{8}$ W.

Let A D again represent $\frac{1}{4}$ W, then D C = H will represent the stress on the horizontal rod, arising from the primary truss; $D_2\,C_2 = H_2$ the stress on the ties of the major secondary truss, and $D_1\,C_1 = H_1$, the stress on the tie rods of the minor secondary trusses. The thrust on the rafter arising from the primary truss is represented by its own length A C = R; that on the lower half of the rafter due to the major secondary truss is represented by $A\ C_2 = R_1$, and on the upper half by $H\ C_2 = R_2$, the difference here arising from the component along the rafter of the weight applied at the points C_2; the stress on the lower half of each portion of the rafter forming part of the minor secondary trusses and arising from the same is $A\ C_2 = R_3$, and that on the upper halves $C_1\,E_1 = R_4$. The resultant stresses on the various parts of the frames therefore will be :—

Pull on the horizontal Tie Rod.

Between $A\,A_1 = H + H_2 + H_1$

" $A_1 + A_2 = H_1 + H_2$

" $A_2\,A_2 = H$

Rankine's Formulæ.

$$\frac{W}{\text{tang. } i}\left(\tfrac{1}{4} + \tfrac{1}{8} + \tfrac{1}{16}\right)$$

$$\frac{W}{\text{tang. } i}\left(\tfrac{1}{4} + \tfrac{1}{8}\right)$$

$$\frac{W}{\text{tang. } i}\left(\tfrac{1}{4}\right)$$

Thrust on the Rafters.

Between $A\,C_1 = R + R_1 + R_3$

" $C_1\,C_2 = R + R_1 + R_4$

" $C_2\,C_3 = R + R_2 + R_3$

" $C_3\,C = R + R_2 + R_4$

Rankine's Formulæ.

$$W \text{ cosec. } i\left(\tfrac{1}{4} + \tfrac{1}{8} + \tfrac{1}{16}\right)$$

$$W \text{ cosec. } i\left(\tfrac{1}{4} + \tfrac{1}{8} + \tfrac{1}{16} - \tfrac{1}{8}\sin^2 i\right)$$

$$W \text{ cosec. } i\left(\tfrac{1}{4} + \tfrac{1}{8} + \tfrac{1}{16} - \tfrac{1}{4}\sin^2 i\right)$$

$$W \text{ cosec. } i\left[\tfrac{1}{4} + \tfrac{1}{8} + \tfrac{1}{16} - \sin^2 i\left(\tfrac{1}{4} - \tfrac{1}{8}\right)\right]$$

The thrust on the struts $C_2\,A_2$ is represented by D E, and that on the struts $C_1\,A_1$ and $C_3\,A_3$ by $D_2\,E_1$.

These various results, rendered in an algebraic form, would be identical with those given by Professor Rankine, which we have transcribed for inspection by the curious; but as these formulæ are rather complicated, and necessitate the use of the trigonometric tables, the diagram of forces which we have here given will be found far more useful in practice.

As the rafters are generally of uniform strength throughout their length, it will be sufficient to define the maximum thrust upon them, and it will be sufficient also to define the minimum and the maximum pull on the tie rod, and the maximum pull on the braces. A careful investigation of the diagram will show that in the case of a principal, trussed in the manner illustrated by Fig. 2, if the rise of the roof be made to represent one-fourth the load on one principal, the maximum thrust on the rafter is represented by $\frac{7}{4}$ its own length; the minimum pull on the tie rod by $\frac{1}{2}$; and the maximum pull by $\frac{7}{8}$ its own length; the maximum pull on the braces is represented by $\frac{3}{8}$ the length of tie rod. Should the minor secondary trusses be left out, the maximum thrust on the rafter will be represented by $\frac{6}{4}$ its own length; the maximum pull on the tie rod by $\frac{3}{4}$ its own length; and the maximum pull on the braces by $\frac{1}{4}$ the length of the tie rod.

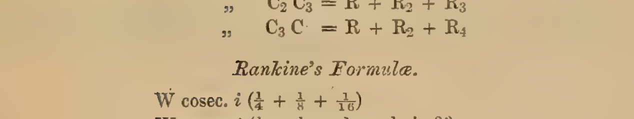


Fig. 3.

Very often, however, the tie rod is raised above the horizontal, and then the diagram of forces assumes a somewhat altered shape. Fig. 3 is an illustration of this case, and the distribution of the load being as previously, if from the point C we draw C D parallel to A A_2, D A will stand for $\frac{1}{4}$ W; C D will represent the pull on the tie A A_2; C D_4, which is horizontal, will represent the pull on the tie $A_2\,A_2$; D D_4, parallel to the brace C A_2, will represent the pull on the same, and A C the thrust on the rafter; all these being due to the primary truss only. The stresses arising from the secondary trusses will be determined as previously, by drawing $C_2\,D_2$ and $C_1\,D_1$ parallel to A A_2; and D H, $D_2\,H_1$, perpendicular to the rafter; finally, the resultant stresses are to be computed as before, care being taken not to omit the additional stress D D_4 on the braces.

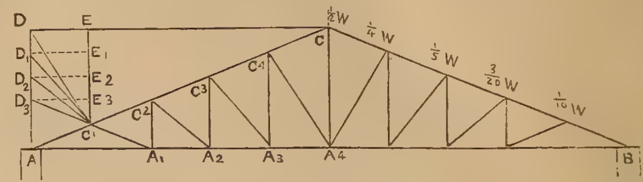


Fig. 4.

Fig. 4 represents a system of trussing very generally adopted, and roofs so constructed are known by the name of king and queen post roofs. The number of secondary trusses to support the rafter varies according to the span; and, in the present case, it is supported by four of these, which are A $A_1\,C_1$, A $A_2\,C_2$, A $A_3\,C_3$, A $A_4\,C_4$, and the stresses again must be determined for each separately. Here the distribution of the load is as follows:—$\frac{1}{5}$ of the weight on the rafter, or $\frac{1}{10}$ W rests directly on each of the points C_1, C_2, C_3, C_4, and $\frac{1}{20}$ W at A and at C; but by means of the vertical ties connecting the trusses one-half the weight at C_1 is transmitted to C_2; $\frac{2}{3}$ of the load at C_2 is transmitted to C_3; $\frac{3}{4}$ of the load at C_3 to C_4 and $\frac{4}{5}$ of that at C_4 to C; so that, finally, we have:—At C $\frac{1}{10}$ W; at C_2 $\frac{3}{20}$ W; at C_3 $\frac{1}{5}$ W; at C_4, $\frac{1}{4}$ W; and at C $\frac{1}{2}$ W. If the rise of the roof be made to represent $\frac{1}{4}$ W, D C = H will represent the pull on the tie rod, and A C = R the thrust on the rafter, as due to the primary truss. To determine the stress upon the component parts of each secondary truss from the point C_1, let us draw the line C_1 D parallel to the strut $C_4\,A_4$, $C_1\,D_1$ parallel to $C_3\,A_3$, $C_1\,D_2$ parallel to $C_2\,A_2$, and $C_1\,D_3$ parallel to $C_1\,A_1$. These lines will respectively represent the thrust upon the struts to which they are parallel: D E = H_1 represents the pull on the tie rod, and A $C_1 = R_1$ the thrust upon the rafter, as due to each secondary truss. It is worth noticing here, that, in this system of trussing, the two latter stresses remain constant for each secondary truss. $C_1\,E_3$, $C_1\,E_2$, $C_1\,E_1$, respectively, represent the pull on the vertical ties $A_1\,C_2$, $A_2\,C_3$, $A_3\,C_4$; and C_1 E represents one-half the pull on the king post A_4 C, the pull here being double that shown by the diagram of forces, because the resultant stress from the corresponding truss on the other rafter is also thrown upon this rod. The resultant stresses, therefore, are as follows:—

Pull on the Tie Rod.

Between $A_3\,A_4 = S + S_1$

" $A_2\,A_3 = S + 2\,S_1$

" $A_1\,A_2 = S + 3\,S_1$

" $A\ \ A_1 = S + 4\,S_1$

Thrust on the Rafter.

Between $C\,C_4 = T$

" $C_3\,C_4 = T + T_1$

" $C_2\,C_3 = T + 2\,T_1$

" $C_1\,C_2 = T + 3\,T_1$

" $A\,C_1 = T + 4\,T_1$

And the maximum stresses are, for the pull on the tie rod, represented by $\frac{9}{10}$ its own length, and for the thrust on the rafter by $\frac{9}{5}$ its own length; but if the number of secondary trusses on each rafter were reduced to three, the maximum stresses would be as in the trussing illustrated by Fig. 2; viz., the thrust on the rafter represented by $\frac{7}{4}$ its own length, and the pull on the tie rod by $\frac{7}{8}$ its own length.

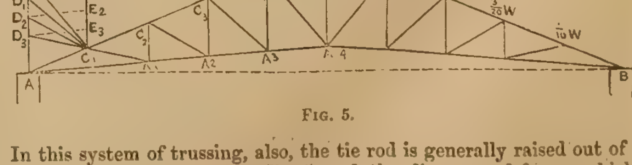


Fig. 5.

In this system of trussing, also, the tie rod is generally raised out of the horizontal line, as shown by Fig. 5, and the diagram of forces, which, it may be well to state, hold good for any number of secondary trusses, undergoes a slight modification. In this case C D is to be drawn parallel to A A_4, and A D = C A_4 is to stand for $\frac{1}{4}$ W; C D then will represent the pull on the tie rod, A C the thrust on the rafter, and 2 D D_4 the pull on the king post, as arising from the primary truss. The stresses due to the secondary trusses, as also the resultant stresses, will now be determined as previously, care being taken not to omit the quantity 2 D D_4, in computing the pull on the king post.

As an example of the application of the foregoing, let us determine the stresses on the various parts of a roof supposed to have a span of 50 feet, with a rise of 10 feet, the principals being 15 feet apart, and trussed according to the method illustrated by Fig. 2. If we assume the load to be 40lbs. per square foot, we shall have $\frac{1}{4}$ W = 3·6 tons, and each lineal foot will represent a pressure of 0·36 tons. The minimum pull on the tie rod will be

$$H = 0{\cdot}36 \text{ tons} \times \frac{50}{2} = 9 \text{ tons}.$$

The maximum pull

$$H + H_2 + H_1 = 0{\cdot}36 \text{ tons} \times 50 \times \tfrac{7}{8} = 15\tfrac{3}{4} \text{ tons}.$$

The maximum pull on the braces

$$H_2 + H_1 = 0{\cdot}36 \text{ tons} \times 50 \times \tfrac{3}{8} = 6\tfrac{3}{4} \text{ tons}.$$

And the pull on the ties of the minor trusses

$$H_1 = 0{\cdot}36 \times 50 \times \tfrac{1}{8} = 2\tfrac{1}{4} \text{ tons}.$$

Which for a unit stress of 5 tons per square inch of section would give the following scantlings:—

for the middle portion of the tie rod

$$\frac{9}{5} = 1{\cdot}8 \text{ sq. in.} = 1\tfrac{1}{2} \text{ in. rod}.$$

for the ends

$$\frac{15{\cdot}75}{5} = 3{\cdot}15 \text{ sq. in.} = 2\text{in. rod}.$$

for the braces

$$\frac{6{\cdot}75}{5} = 1{\cdot}35 \text{ sq. in.} = 1\tfrac{5}{16} \text{ in. rod}.$$

and for the small ties

$$\frac{2{\cdot}25}{5} = 0{\cdot}45 \text{ sq. in.} = \tfrac{3}{4}\text{in. rod}.$$

The length of the rafter is 27 feet, and the maximum thrust on it will be

$$R + R_1 + R_3 = 0{\cdot}36 \text{ tons} \times 25 \times \tfrac{7}{4} = 17 \text{ tons}.$$

Which, for a load of 5 tons to the square inch, would give an area of $3\frac{1}{2}$ square inches. Here, however, we must remember that the rafter is not only a strut, but that it is also a beam, subject to deflection by a bending moment, whose value, in the present instance, is

$$M = \tfrac{1}{64} \times 7{\cdot}2 \text{ tons} \times 25\text{ft.} \times 12\text{in.}$$

where the factor $\frac{1}{64}$ arises from the fact of the rafter being a continuous beam, supported in three points, and whose ends cannot take any deflection. Under these circumstances, the rafter should be made subject to the condition expressed by the following formula:—

$$S = \frac{R + R_1 + R_3}{A} + \frac{M d_1}{I} \quad . \; . \; . \; . \quad (1)$$

where S stands for the unit strain, A the transverse area of the rafter, I the moment of inertia of the cross section and d_1 the distance of the fibre farthest removed from the centre of gravity of that transverse section. Now rafters are generally made of two angle irons, bolted together back to back, or of ⊤ iron, and for either of these sections we can write, with sufficient accuracy, for all practical purposes

$$\frac{I}{d_1} = \frac{1}{4{\cdot}5} A\, d$$

where d stands for the whole depth of the ⌊ or ⊤ iron.

For the case under consideration, therefore, formula (1) would read thus:

$$S = 5 \text{ tons} = \frac{17 \text{ tons}}{A} + \frac{7{\cdot}2 \text{ tons} \times 25\text{ft.} \times 12\text{in.} \times 4{\cdot}5}{64 \,.\, A\, d} \quad . \; . \; . \quad (2.)$$

and assuming d at $5\frac{1}{2}$ inches, would give for the value of A:

$$A = \frac{17 \text{ tons}}{5} + \frac{7{\cdot}2 \text{ tons} \times 25\text{ft.} \times 12\text{in.} \times 4{\cdot}5}{64 \times 5 \times 5{\cdot}5} = 8\tfrac{1}{2} \text{ sq. in.}$$

equivalent to two ⌊ irons bolted back to back, each $5\frac{1}{2}$in. × $2\frac{1}{2}$in. × $\frac{9}{16}$.

Professor Rankine does not caution his readers about the important fact that the rafter is to be treated as a beam subject to deflection by transverse strain, but simply makes it known as a *strut*, and defines the amount of the thrust, which, under certain circumstances, it will have to resist. The above calculation, however, shows that the area required to resist the thrust is $3\frac{1}{2}$ square inches only against 5 square inches required to resist the bending moment, and conclusively shows that a roof, calculated in strict accordance with the formulæ given by Professor Rankine, would be ridiculously deficient of strength in one of its most important parts. Possibly, however, he did not so much intend to give a theory of the stability of roofs, as to adduce examples of trussed frames of which he treats especially in that chapter; but in regard to this, we must observe that authors of his class, who are acknowledged and who acknowledge themselves leaders in mechanical science will be held responsible for any mishaps that may or shall arise from certain questions having been treated incompletely, in those of their works written for the use and guidance of practical men.

General Morin, who among a certain class of his countrymen, has the reputation of being too careful and too heavy in his practical formulæ, strange to say, errs upon this subject in a manner similar to Professor Rankine. Starting with the correct assumption that the rafter is to be considered as an oblique beam under uniform load, and subject at the same time to a certain thrust from the reaction of the tie rod, he lays down a formula, which, containing both these elements of stress would lead to a perfectly correct result; but without any closer investigation of the subject, he then assumes it as an *a priori* fact that the element of stress, arising from the thrust, will always be so small as to be of no material consequence, and wipes out in his formula that part of it providing for the same. We have seen however that, in the calculations of the example chosen, the proportion of area arising from the thrust, is to that arising from the moment of flexion as 7 is to 10; and in cases where the trussing is carried still further these relative amounts would approach more and more to an equality, plainly showing that the *a priori* assumption, upon which General Morin has based his subsequent calculations, is altogether erroneous, and fraught with dangerous consequences.

We earnestly hope that this author, generally so careful and so practical, will be made alive to the error which we have just pointed out, and that before any considerable mischief is done he will revise his elaborate tables on the scantlings of rafters, for the benefit of all those whom it may concern.

(*To be continued.*)

STRENGTH OF MATERIALS.

DEDUCED FROM THE LATEST EXPERIMENTS OF BARLOW, BUCHANAN, FAIRBAIRN, HODGKINSON, STEPHENSON, MAJOR WADE, U.S. ORDNANCE CORPS, AND OTHERS.

(*Continued from page* 152.)

SHAFTS AND GUDGEONS.

Shafts are divided into shafts and spindles, according to their magnitude.

A gudgeon is the metal journal or arbor on which a wooden shaft revolves.

Shafts are subjected to torsion* and lateral stress combined, or to lateral stress alone.

LATERAL STIFFNESS AND STRENGTH.

Shafts of equal length have lateral stiffness as their breadth and the cube of their depth, and have lateral strength as their breadth and the square of their depth.

Hence, in shafts of equal length, their stiffness by any increase of depth, increases in a greater proportion than their strength.

Shafts of different lengths have lateral stiffness, directly as their breadth and the cube of their depth, and inversely as the cube of their length, and have lateral strength directly as their breadth and as the square of their depth, and inversely as their length.

Hence, in shafts of different lengths, their stiffness by any increase of their length, decreases in a greater proportion than their strength.

Hollow shafts having equal lengths and equal quantities of material, have lateral stiffness as the square of their diameter, and have lateral strength as their diameters.

Hence, in hollow shafts, one having twice the diameter of another, will have four times the stiffness and but double the strength, and when having equal lengths, by an increase in diameter they increase in stiffness in a greater proportion than in strength.

The stress upon a shaft from a weight upon it, is proportional to the product of the parts of the shaft multiplied into each other.

* For rules for torsional strength see page 150.

Thus, if a shaft is 10ft. in length, and a weight on the centre of gravity of the stress, is at a point 2ft. from one end, the parts 2 and 8 multiplied together are equal to 16; but if the weight or stress were applied in the middle of the shaft, the parts 5 and 5 multipled together would produce 25.

The ends of a shaft having to support the whole weight, the end which is nearest the weight has to support the greatest proportion of it, in the inverse proportion of the distance of the weight from the end. Hence, when a shaft is loaded in the middle, each of the journals or gudgeons has half the weight or stress to support.

When the load upon a shaft is uniformly distributed over any part of it, it is considered as united in the middle of that part, and if the load is not uniformly distributed, it is considered as united at its centre of gravity.

When the transverse section of a shaft is a regular figure, as a square, circle, &c., and the load is applied in one point, in order to give it equal resistance throughout its length, the curve of the sides becomes a cubic parabola; but when the load is uniformly distributed over the shaft, the curve of the sides becomes a semi-cubical parabola.

The deflection of a shaft produced by a load which is uniformly distributed over its length, is the same as when five-eighths of the load is applied at the middle of its length.

The resistance of the body of a shaft to lateral stress, is as its breadth and the square of its depth: hence, the diameter will be as the product of the length of it and the length of it one side of a given point, less the square of that length.

Illustration.—The length of a shaft between the centres of its journals is 10 feet: what should the relative cubes of its diameters when the load is applied at 1, 2, and 5ft. from one end? and what when the load is uniformly distributed over the length of it?

$l \times l^1 - l^2 = d^3$, and when uniformly distributed $d^3 \div 2 = d^1$.

$10 \times 1 = 10 - 1^2 = 9$ = cube of diameter at 1 foot.
$10 \times 2 = 20 - 2^2 = 16$ = „ „ 2 „
$10 \times 5 = 50 - 5^2 = 25$ = „ „ 5 „

When a load is uniformly distributed, the stress is greatest at the middle of the length and is equal to half of it; if collected in the middle, and when the load is uniformly distributed—

$25 \div 2 = 12.5$ = cube of diameter at 5 feet.

Cylindrical Shafts.

To ascertain the Diameter of a Cast Iron Shaft to resist Lateral Stress alone.

When the Stress is in or near the Middle.

Rule.—Multiply the weight by the length of the shaft in feet, divide the product by 500, and the cube root of the quotient will give the diameter in inches.

Example.—The weight of a water-wheel upon a shaft is 50,000lbs., its length 30ft., and the centre of gravity of the wheel 7ft. from one end; what should be the diameter of the body?

$$\sqrt[3]{\left(\frac{50,000 \times l}{500}\right)} = 14.422 \text{ inches,}$$

if the weight was in the middle of its length.

Hence, the diameter at 7 feet from one end will be, as by preceding rule,

$30 \times 7 - 7^2 = 161$ = relative cube of diameter at 7 feet.
$30 \times 15 - 15^2 = 225$ = relative cube of diameter at 15 feet.

Then as $\sqrt[3]{225} : 14.42 :: \sqrt[3]{161} : 12.89$ inches,

the diameter of the shaft at 7 feet from one end.

When the Stress is uniformly Laid along the Length of the Shaft.

Rule.—Divide the cube root of the product of the weight and the length by 9·3, and the quotient will give the diameter in inches.

Example.—Apply the rule to the preceding case.

$$\frac{\sqrt[3]{50,000 \times 30}}{9.3} = 12.31 \text{ inches.}$$

Or, when the diameter for the stress applied in the middle is given.

Rule.—Take the cube root of five-eighths of the cube of the diameter, and this root will give the diameter required.

Example.—The diameter of a shaft when the stress is uniformly applied along its length is 14·422ins. What should be its diameter, the stress being applied in the middle.

$$\sqrt[3]{\tfrac{5}{8} \times 14.422^3} = \sqrt[3]{\tfrac{5}{8} \times 3000} = 12.33 \text{ inches.}$$

Hollow Shafts of Cast Iron.

When the Stress is in or near the Middle.

Rule.—Divide the continued product of ·012 times the cube of the length and the number of times the weight of the shaft in pounds by the sum of the internal diameter added to 1, and twice the square root of the quotient added to the internal diameter, will give the whole diameter in inches.

Example.—The weight of a water-wheel upon a hollow shaft 30ft. in length is 2·5 times its own weight, and the internal diameter is 9ins.; what should be the whole diameter of the shaft?

$$\sqrt{\left(\frac{.012 \times 30^3 \times 2.5}{1 + 9^2}\right)} = \sqrt{\frac{810}{82}} = 3.14 \text{ inches.}$$

Then

$$9 + \overline{3.14 \times 2} = 15.28 \text{ inches, the whole diameter.}$$

To ascertain the Diameter of a Cast Iron Shaft to resist its own Weight alone.

Rule.—Multiply the cube of its length by ·007, and the square root of the product will give the diameter in inches.

Example.—The length of a shaft is 30ft.; what should be its diameter in the body?

$$\sqrt{(30^3 \times .007)} = \sqrt{189} = 13.75 \text{ inches.}$$

When a Shaft has to resist both Torsional and Lateral Stress combined. To ascertain its Diameter, the Stress being applied in the Middle.

Rule.—Ascertain the diameter for each stress, and the cube root of the sum of their cubes will give the diameter required.

Example.—The diameter of the journal of a shaft to resist torsional stress is ascertained to be 17ins., and the diameter of its body in the centre to resist lateral stress, has also been ascertained to be 14·422ins.; what should be the diameter of the body?

$$\sqrt[3]{(17^3 + 14.422^3)} = \sqrt[3]{7913} = 19.927 \text{ inches.}$$

The strength of a cylindrical shaft compared to a square one, the diameter of the one being equal to the side of the other, is as 1 to 1·7, and of a square shaft to a cylindrical as 1 to ·589.

To ascertain the Diameter of Shafts of Wrought Iron, Oak, and Pine.

Multiply the diameter ascertained for cast-iron as follows:

Wrought-iron	by	·935
Oak	„	1·83
Yellow pine	„	1·716

To ascertain the Deflection of a Cylindrical Shaft.

Rule.—Divide the square of three times the length in feet by the product of the following constants and the square of the diameter in inches, and the quotient will give the deflection.

Cast-iron,	Cylindrical shaft	1500
do.	Square do.	2560
Wrought-iron,	Cylindrical do.	1980
do.	Square do.	3360

Example.—The length of a cast-iron cylindrical shaft is 30ft., and its diameter in the centre 15in., what is its deflection?

$$\frac{\overline{30 \times 3}^2}{1500 \times 15^2} = \frac{8100}{337500} = .024 \text{ inches.}$$

To ascertain the Length of a Cylindrical Shaft.

Rule.—Multiply the preceding constant by the deflection, and the square of the diameter and one-third of the square root of the product will give the length in feet.

Example.—The diameter of a cast-iron cylindrical shaft is 15in., and the deflection assigned to it is ·024; what should be its length?

$$\sqrt{\frac{1500 \times .024 \times 15^2}{3}} = \frac{90}{3} = 30 \text{ ft.}$$

Gudgeons.

To ascertain the Diameter of a single Gudgeon to support a given stress or weight.

Rule.—Divide the square root of the weignt in pounds by 25 for cast-iron, and 26 for wrought-iron, and the quotient will give the diameter in inches.

Example.—The weight on a gudgeon of a cast-iron water-wheel shaft is 62,500lbs.; what should be its diameter?

$$\sqrt{\frac{62,500}{25}} = \frac{250}{25} = 10 \text{ ins.}$$

(To be continued.)

STRENGTH OF CAST AND WROUGHT IRON PILLARS.

Continued from page 154.

Hollow Uniform Cylindrical Pillars of Cast Iron, both Ends being flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formula, $W = 44{\cdot}34\frac{D^{3{\cdot}55} - d^{3{\cdot}55}}{L^{1{\cdot}7}}$.	Calculated breaking weight in tons from formula, $Y = \frac{b\,c}{b + \frac{3}{4}c}$.	Safe weight in tons.
8	$9\frac{3}{5}$	10	$8\frac{1}{2}$	545·46	....	764·06	191·01
9	$10\frac{4}{5}$	10	$8\frac{1}{2}$	613·64	....	718·68	179·67
10	12	10	$8\frac{1}{2}$	681·83	....	675·32	168·83
11	$13\frac{1}{5}$	10	$8\frac{1}{2}$	750·01	....	634·29	158·57
12	$14\frac{2}{5}$	10	$8\frac{1}{2}$	818·19	....	595·70	148·92
13	$15\frac{3}{5}$	10	$8\frac{1}{2}$	886·37	....	559·62	139·90
14	$16\frac{4}{5}$	10	$8\frac{1}{2}$	954·56	....	525·98	131·49
15	18	10	$8\frac{1}{2}$	1022·74	....	494·73	123·68
16	$19\frac{1}{5}$	10	$8\frac{1}{2}$	1090·92	....	465·73	116·43
17	$20\frac{2}{5}$	10	$8\frac{1}{2}$	1159·11	....	438·85	109·71
18	$21\frac{3}{5}$	10	$8\frac{1}{2}$	1227·29	....	413·98	103·49
19	$22\frac{4}{5}$	10	$8\frac{1}{2}$	1295·47	....	390·92	97·73
20	24	10	$8\frac{1}{2}$	1363·66	....	369·56	92·39
21	$25\frac{1}{5}$	10	$8\frac{1}{2}$	1431·84	....	349·78	87·44
22	$26\frac{2}{5}$	10	$8\frac{1}{2}$	1500·02	....	331·43	82·85
23	$27\frac{3}{5}$	10	$8\frac{1}{2}$	1568·20	....	314·41	78·60
24	$28\frac{4}{5}$	10	$8\frac{1}{2}$	1636·39	....	298·60	74·65
25	30	10	$8\frac{1}{2}$	1704·57	....	283·90	70·97
26	$31\frac{1}{5}$	10	$8\frac{1}{2}$	1772·75	....	270·22	67·55
27	$32\frac{2}{5}$	10	$8\frac{1}{2}$	1840·94	254·44	....	63·61
28	$33\frac{3}{5}$	10	$8\frac{1}{2}$	1909·12	239·18	....	59·79
29	$34\frac{4}{5}$	10	$8\frac{1}{2}$	1977·30	225·32	....	56·33
30	36	10	$8\frac{1}{2}$	2045·49	212·70	....	53·17
8	$8\frac{8}{11}$	11	$9\frac{1}{2}$	604·43	....	883·38	220·84
9	$9\frac{9}{11}$	11	$9\frac{1}{2}$	679·98	....	836·33	209·08
10	$10\frac{10}{11}$	11	$9\frac{1}{2}$	755·54	....	790·80	197·70
11	12	11	$9\frac{1}{2}$	831·09	....	747·17	186·79
12	$13\frac{1}{11}$	11	$9\frac{1}{2}$	906·64	....	705·67	176·41
13	$14\frac{2}{11}$	11	$9\frac{1}{2}$	982·20	....	666·44	166·61
14	$15\frac{3}{11}$	11	$9\frac{1}{2}$	1057·75	....	629·50	157·37
15	$16\frac{4}{11}$	11	$9\frac{1}{2}$	1133·31	....	594·84	148·71
16	$17\frac{5}{11}$	11	$9\frac{1}{2}$	1208·86	....	562·39	140·59
17	$18\frac{6}{11}$	11	$9\frac{1}{2}$	1284·41	....	532·06	133·01
18	$19\frac{7}{11}$	11	$9\frac{1}{2}$	1359·97	....	503·77	125·94
19	$20\frac{8}{11}$	11	$9\frac{1}{2}$	1435·52	....	477·36	119·34
20	$21\frac{9}{11}$	11	$9\frac{1}{2}$	1511·08	....	452·74	113·18
21	$22\frac{10}{11}$	11	$9\frac{1}{2}$	1586·63	....	429·79	107·44
22	24	11	$9\frac{1}{2}$	1662·18	....	408·38	102·09
23	$25\frac{1}{11}$	11	$9\frac{1}{2}$	1737·74	....	388·41	97·10
24	$26\frac{2}{11}$	11	$9\frac{1}{2}$	1813·29	....	369·77	92·44
25	$27\frac{3}{11}$	11	$9\frac{1}{2}$	1888·85	....	352·36	88·09
26	$28\frac{4}{11}$	11	$9\frac{1}{2}$	1964·40	....	336·09	84·02
27	$29\frac{5}{11}$	11	$9\frac{1}{2}$	2039·95	....	320·86	80·21
28	$30\frac{6}{11}$	11	$9\frac{1}{2}$	2115·51	....	306·60	76·65
29	$31\frac{7}{11}$	11	$9\frac{1}{2}$	2191·06	292·36	....	73·09
30	$32\frac{8}{11}$	11	$9\frac{1}{2}$	2266·62	275·98	....	68·99

Solid Uniform Cylindrical Pillars of Cast Iron, Both Ends being Rounded or Irregularly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	Diameter in inches.	Calculated breaking weight in tons from other formulæ.	Calculated breaking weight in tons from formula, $W = 14{\cdot}9\frac{D^{3{\cdot}76}}{L^{1{\cdot}7}}$.	Safe weight in tons.
5	13·333	$4\frac{1}{2}$	153·57	....	38·34
6	16.	$4\frac{1}{2}$	133·20	....	33·30
7	18·666	$4\frac{1}{2}$	116·05	....	29·01
8	21·333	$4\frac{1}{2}$	101·58	....	25·39
9	24·	$4\frac{1}{2}$	89·08	....	22·27
10	26·666	$4\frac{1}{2}$	79·17	....	19·79
11	29·333	$4\frac{1}{2}$	70·50	....	17·62
12	32·	$4\frac{1}{2}$	....	62·32	15·58
13	34·666	$4\frac{1}{2}$	....	54·39	13·59
14	37·333	$4\frac{1}{2}$	....	47·95	11·98
15	40·	$4\frac{1}{2}$	....	42·64	10·66
16	42·666	$4\frac{1}{2}$	....	38·21	9·55
17	45·333	$4\frac{1}{2}$	....	34·47	8·61
18	48·	$4\frac{1}{2}$	....	31·28	7·82
19	50·666	$4\frac{1}{2}$	....	28·53	7·13
20	53·333	$4\frac{1}{2}$	....	26·15	6·53
5	12·	5	203·72	....	50·93
6	14·4	5	179·44	....	44·86
7	16·8	5	158·24	....	39·56
8	19·2	5	139·96	....	34·99
9	21·6	5	124·28	....	31·07
10	24·	5	110·86	....	27·71
11	26·4	5	99·35	....	24·83
12	28·8	5	89·46	....	22·3
13	31·2	5	....	80·83	20·20
14	33·6	5	....	71·26	17·81
15	36·	5	....	63·38	15·84
16	38·4	5	....	56·79	14·19
17	40·8	5	....	51·23	12·80
18	43·2	5	....	46·48	11·62
19	45·6	5	....	42·40	10·60
20	48·	5	....	38·86	9·71
5	10·	6	326·77	....	81·69
6	12·	6	294·55	....	73·63
7	14·	6	265·17	....	66·29
8	16·	6	238·83	....	59·70
9	18·	6	215·47	....	53·86
10	20·	6	194·86	....	48·71
11	22·	6	176·74	....	44·18
12	24·	6	160·79	....	40·19
13	26·	6	147·03	....	36·75
14	28·	6	134·38	....	33·59
15	30·	6	123·44	....	30·86
16	32·	6	....	112·72	28·18
17	34·	6	....	101·68	25·42
18	36·	6	....	92·20	23·05
19	38·	6	....	84·16	21·04
20	40·	6	....	77·13	19·28

Table showing the Breaking Weight of Hollow Cylindrical Pillars for Different Qualities of Cast Iron, both Ends being Flat and firmly Fixed.

The formulæ for the breaking weight by which the following table for hollow pillars, and a preceding similar one for solid pillars, were calculated, are as under :—

For the solid pillars, $W = m \times \frac{D^{3\cdot55}}{L^{1\cdot7}}$.

For the hollow pillars, $W = m \times \frac{D^{3\cdot55} - d^{3\cdot55}}{L^{1\cdot7}}$.

m representing a weight varying from 78,400 lbs. to 134,400 lbs., the higher ones being used as examples only.

The co-efficients given by Mr. Hodgkinson are of course not applicable for the strength of all cast iron; therefore the weight must vary according to the strength of the material.

Height of Pillar in feet.	Number of diams. contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Co-efficient for the strength, in lbs.					
				78,400	89,600	100,800	112,000	123,200	134,400
				Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
8	48	2	1	10·93	12·49	14·05	15·61	17·17	18·74
10	60	2	1	7·48	8·55	9·61	10·68	11·75	12·82
10	40	3	2	26·32	30·08	33·84	37·60	41·36	45·12
12½	50	3	2	18·01	20·58	23·15	25·73	28·30	30·87
12½	37½	4	3	41·95	47·94	53·93	59·92	65·92	71·91
15	45	4	3	30·77	35·16	39·56	43·95	48·35	52·74
15½	37⅕	5	4	54·94	62·79	70·64	78·49	86·33	94·18
17	40⅘	5	4	46·95	53·66	60·37	67·08	73·79	80·50
17½	35	6	5	74·37	84·99	95·62	106·24	116·87	127·49
20	40	6	5	59·26	67·73	76·14	84·66	93·13	101·60

Hollow Cylindrical Pillars for different Qualities of Cast Iron, both Ends being Flat and firmly Fixed.

Height of Pillar in feet.	Number of diams. contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Value of b in tons from formula, $b = 44{\cdot}34\ \frac{D^{3\cdot55} - d^{3\cdot55}}{L^{1\cdot7}}$.	Value of c, in tons.	Breaking weight in tons from formula, $Y = \frac{b\ c}{b + \frac{3}{4}c}$.
15	30	6	5	122·45	381·86	114·36
15	30	6	5	122·45	423·33	117·82
15	30	6	5	122·45	477·32	121·65
				$b = 40{\cdot}00\ \frac{D^{3\cdot55} - d^{3\cdot55}}{L^{1\cdot7}}$.		
15	30	6	5	110·46	381·86	106·28
				$b = 50{\cdot}00\ \frac{D^{3\cdot55} - d^{3\cdot55}}{L^{1\cdot7}}$.		
15	30	6	5	138·08	477·32	132·86
				$b = 42{\cdot}347\ \frac{D^{3\cdot5} - d^{3\cdot5}}{L^{1\cdot63}}$.		
15	30	6	5	127·93	381·86	117·90
15	30	6	5	127·93	423·33	121·58
15	30	6	5	127·93	477·32	125·66
				$b = 46{\cdot}65\ \frac{D^{3\cdot55} - d^{3\cdot55}}{L^{1\cdot7}}$.		
15	30	6	5	128·83	381·86	118·47
15	30	6	5	128·83	423·33	122·19
15	30	6	5	128·83	477·32	126·31
				$b = 35{\cdot}00\ \frac{D^{3\cdot55} - d^{3\cdot55}}{L^{1\cdot7}}$.		
15	30	6	5	96.65	334·08	92·99

Mr. Hodgkinson found that the weight which would crush the pillars, if they were very short, would vary as 5 to 9 nearly, and for long flexible pillars he found the weight varied from 49 94 tons, in the strongest iron he tried, to 33·60 tons in the weakest. Therefore, if we take the case of a hollow cylindrical pillar, of 6 inches external diameter and 5 inches internal diameter, beginning at 10 diameters or 5 feet high, the co-efficient for the strength will be 16·91 tons, for 6 feet high 20·88 tons, for 7 feet high 24·56 tons, for 8 feet high 27·84 tons, and so on, increasing till we arrive at 44·34 tons, for a trifle above 16 feet or 32 diameters. And in the case of a solid pillar of the same height and 6 inches diameter, the co-efficient for the strength will be 22·69 tons, increasing in a similar manner as in the above, till we arrive at 44·16 tons, or about 12½ feet or 25 diameters.

I have previously remarked that the breaking weight of pillars is not critically correct for pillars with flat ends whose height is only 30 diameters. I should have expressed it as applying only to hollow ones, as the nearer we approach to a solid the farther we recede below 30 diameters, approaching nearer and nearer to 25 diameters, as in the solid pillars with flat ends, as will be seen by inspection of the following table for a hollow pillar, 15 feet high, and 6 inches external diameter. It is also made plain by this table, that a hollow pillar, 15 feet high, 6 inches external diameter, and whose sectional thickness is two inches, will support very nearly the same weight as a solid one of the same height and 6 inches diameter, with a saving in the weight of metal of 147·41 lbs.; that is, that 1179·37 lbs. will support as a hollow cylinder nearly as great a weight as a solid one containing 1326·78 lbs.; the safe weight of the former being 62·94 tons, and that of the latter 63·98 tons.

Table referred to in the above.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in pillar in lbs.	Value of b in tons from formula, $b = 44{\cdot}34\ \frac{D^{3\cdot55} - d^{3\cdot55}}{L^{1\cdot7}}$.	Value of c, in tons.	Value of Y in tons from formula, $Y = \frac{b\ c}{b + \frac{3}{4}c}$.	Breaking weight in tons.
15	30	6	5	405·40	122·45	423·33	117·82	117·82
15	30	6	4½	578·94	164·42	606·23	161·00	161·00
15	30	6	4	737·10	196·04	769·69	195·12	195·12
15	30	6	3½	875·31	219·04	914·00	221·33	219·04
15	30	6	3	995·10	235·03	1039·08	240·76	235·03
15	30	6	2	1179·37	251·76	1231.50	263·77	251·76
15	30	6	...	1326·78	....	......	....	....

Breaking weight of solid pillar in tons from formula $W = 44{\cdot}16\ \frac{D^{3\cdot55}}{L^{1\cdot7}}$, 255·92.

The following table will show a few hollow pillars of different dimensions having a corresponding breaking weight as the pillar referred to above; also, the safe weight of each, and their weight of metal :—

Length or height of Pillar in feet.	External diameter in inches.	Internal diameter in inches.	Weight of metal.	Breaking weight in tons.	Safe weight in tons.
10	6	4½	385·96	253·86	63·46
14	7	5½	643·24	250·23	62·55
18	8	6½	961·93	253·67	63·41
22½	9	7½	1368·26	253·79	63·44
27	10	8½	1840·94	254·44	63·61
12	6	4	589·68	255·29	63·82
16½	7	5	972·98	254·39	63·59
21¼	8	6	1461·93	252·54	63·13

I shall not in this series give any further tables for cast iron pillars with rounded ends, conceiving it sufficient for all practical purposes to assume one-ninth or one-tenth of the breaking weight of pillars with flat ends as a correct approximation for the safe weight if irregularly fixed, imperfectly set, or not truly perpendicular.

I have also, in a previous paper, given a table for pillars whose heights were less than 3I diameters with rounded ends; and, as I have omitted similar pillars with flat ends of the same dimensions, that should have preceded those with rounded ends, I introduce the following table to supply the deficiency.

Hollow Uniform Cylindrical Pillars of Cast Iron, both ends being Flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formulæ, $b = 44{\cdot}34\,\frac{D^{3\cdot55} - d^{3\cdot55}}{L^{1\cdot7}}$, $Y = \frac{b\,c}{b + \frac{3}{4}c}$.	Safe weight in tons.	Safe weight if irregularly fixed, in tons.
8	24	4	2	235·87	147·30	36·82	14·73
$9\frac{1}{2}$	$28\frac{1}{2}$	4	2	280·09	119·65	29·91	11·96
10	30	4	2	294·84	111·01	27·75	11·10
8	$19\frac{1}{5}$	5	3	314·49	255·60	63·90	25·56
10	24	5	3	393·12	201·29	50·32	20·12
12	$28\frac{4}{5}$	5	3	471·74	161·74	40·43	16·17
8	16	6	4	393·12	382·66	95·66	38·26
10	20	6	4	491·40	310·61	77·65	31·06
12	24	6	4	589·68	255·29	63·82	25·52
14	28	6	4	687·96	212·69	53·17	21·26
15	30	6	4	737·10	195·12	48·78	19·51
10	$17\frac{1}{7}$	7	5	589·69	435·06	108·76	43·50
12	$20\frac{4}{7}$	7	5	707·62	364·93	91·23	39·49
14	24	7	5	825·56	308·93	77·23	30·89
15	$25\frac{5}{7}$	7	5	884·53	285·31	71·32	28·53
16	$27\frac{3}{7}$	7	5	943·50	264·14	66·03	26·41
$16\frac{1}{2}$	$28\frac{2}{7}$	7	5	972·98	254·39	63·59	25·43
12	18	8	6	825·56	487·28	121·82	48·72
14	21	8	6	963·15	418·58	104·64	41·85
15	$22\frac{1}{2}$	8	6	1031·95	388·98	97·24	38·89
16	24	8	6	1100·75	362·14	90·53	36·21
18	27	8	6	1238·34	315·68	78·92	31·56
20	30	8	6	1375·94	277·22	69·30	27·72
14	$16\frac{4}{5}$	10	8	1238·34	668·65	167·16	66·86
15	18	10	8	1326·79	628·21	157·05	62·81
16	$19\frac{1}{5}$	10	8	1415·24	590·77	147·69	59·07
18	$21\frac{3}{5}$	10	8	1592·15	524·13	131·03	52·41
20	24	10	8	1769·06	467·15	116·78	46·71
15	15	12	10	1621·63	898·08	224·52	89·80
16	16	12	10	1729·74	851·69	212·92	85·16
18	18	12	10	1945·96	767·17	191·79	76·71
20	20	12	10	2162·18	692·82	173·20	69·28
22	22	12	10	2378·39	627·60	156·90	62·76
25	25	12	10	2702·72	544·44	136·11	54·44
30	30	12	10	3243·27	436·76	109·19	43·67

Mr. Henry Law informs us that the following formula is Mr. Hodgkinson's for the strength of a hollow cylindrical column of wrought iron with both ends flat, when the height of the column is not less than 30 times its diameter :—

$$W = 77{\cdot}2\ \frac{D^{3\cdot6} - d^{3\cdot6}}{L^{1\cdot7}}$$

and Mr. Jos. W. Sprague, in an article advocating his wrought iron bridge truss, says that "Hodgkinson's formula for the value of W, in tons, is—

$$W = 133{\cdot}75\ \frac{D^{3\cdot55} - d^{3\cdot55}}{L^{2}},$$

when the length of the column exceeds thirty times its diameter."

Up to the present I have not been able to discover that either of the above formulæ has emanated from Mr. Hodgkinson; but, as an example, I give below the result of my calculations deduced from each of them.

Table comparing the Strength of Hollow Cylindrical Pillars of Wrought Iron, by the formulæ above referred to.

Length or height of pillar in feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated breaking weight in tons from formulæ, $W = 77{\cdot}2\,\frac{D^{3\cdot6} - d^{3\cdot6}}{L^{1\cdot7}}$.	Calculated breaking weight in tons from formulæ, $W = 133{\cdot}75\,\frac{D^{3\cdot55} - d^{3\cdot55}}{L^{2}}$.
$17\frac{1}{2}$	35	6	5	181·20	120·42
20	40	6	5	144·40	92·20
20	40	6	$5\frac{1}{2}$	80·68	51·42
$17\frac{1}{2}$	35	6	$5\frac{1}{2}$	101·25	67·16

There are so many considerations requisite, and all of them likely to lead to complicated results, that I shall make no attempt to form a table for the strength of hollow cylindrical pillars of wrought iron.

Tables showing the calculated Breaking Weight and Safe Weight of uniform solid Cylindrical Pillars of Wrought Iron, and the calculated Weight of Metal contained in each Pillar.

Solid Uniform Cylindrical Pillars of Wrought Iron, both ends being Flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	Diameter in inches.	Calculated weight of metal contained in the Pillar, in lbs.	Calculated breaking weight in tons from formulæ, $W = 133{\cdot}75\,\frac{D^{3\cdot55}}{L^{2}}$.	Calculated breaking weight in tons from formulæ, $Y = \frac{bc}{b + \frac{3}{4}c}$.	Safe weight in tons.	Safe weight if irregularly fixed, in tons.
5	30	2	53·07	....	54·14	13·53	5·41
6	36	2	63·68	43·51	....	10·87	4·35
7	42	2	74·29	31·97	....	7·99	3·19
8	48	2	84·91	24·47	....	6·11	2·44
9	54	2	95·52	19·34	....	4·83	1·93

Solid Uniform Cylindrical Pillars of Wrought Iron, both Ends being Flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	Diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formula, $W=133{\cdot}75\frac{D^{3\cdot55}}{L^2}$.	Calculated breaking weight in tons from formula, $Y=\frac{bc}{b+\frac{3}{4}c}$.	Safe weight in tons.	Safe weight if irregularly fixed, in tons.
10	60	2	106·14	15·66	...	3·91	1.56
11	66	2	116·75	12·94	...	3·23	1·29
12	72		127·36	10·87	...	2·71	1·08
13	78	2	137·98	9·26	...	2·31	0·92
14	84	2	148·59	7·99	...	1·99	0·79
15	90	2	159·21	6·96	...	1·74	0·69
16	96	2	169·82	6·11	...	1·52	0·61
17	102	2	180·48	5·42	...	1·35	0·54
18	108	2	191·05	4·83	...	1·20	0·48
19	114	2	201·66	4·33	...	1·08	0·43
20	120	2	212·28	3·91	...	0·97	0·39
5	24	2½	82·92	...	104·39	26·09	10·43
6	28·8	2½	99·51	...	83·58	20·89	8·35
7	33·6	2½	116·09	70·59	...	17·64	7·05
8	38·4	2½	132·68	54·04	...	13·51	5·40
9	43·2	2½	149·26	42·70	...	10·67	4·27
10	48	2½	165·85	34·59	...	8·64	3·45
11	52·8	2½	182·43	28·58	...	7·14	2·85
12	57·6	2½	199·02	24·02	...	6·00	2·40
13	62·4	2½	215·60	20·46	...	5·11	2·04
14	67·2	2½	232·19	17·64	...	4·41	1·76
15	72	2½	248·77	15·37	...	3·84	1·53
16	76·8	2½	265·36	13·51	...	3·37	1·35
17	81·6	2½	281·94	11·96	...	2·99	1·19
18	86·4	2½	298·53	10·67	...	2·66	1·06
19	91·2	2½	315·11	9.58	...	2·39	0·95
20	96	2½	331·70	8·64	...	2·16	0·86
5	20	3	119·42	...	174·67	43·66	17·46
6	24	3	140·30	...	143·40	35·85	14·34
7	28	3	167·18	...	118·35	29·58	11·83
8	32	3	191·07	98·49	...	24·62	9·84
9	36	3	214·95	81·44	...	20·36	8·14
10	40	3	238·84	66·07	...	16·51	6·60
11	44	3	262·72	54·60	...	13·65	5·46
12	48	3	286.60	45·88	...	11·47	4·58
13	52	3	310·49	39·09	...	9·77	3·90
14	56	3	334·37	33·71	...	8·42	3·37
15	60	3	358·26	29·36	...	7·34	2·93
16	64	3	382·14	25·80	...	6·45	2·58
17	68	3	406·02	22·86	...	5·71	2·28
18	72	3	429·91	20·39	...	5·09	2·03
19	76	3	453·79	18·30	...	4·57	1·83
20	80	3	477·68	16·51	...	4·12	1·65
5	17·142	3½	162·55	...	265·75	66·43	26·57
6	20·571	3½	195·06	...	222·95	55·73	22·29
7	24	3½	227·57	...	187·30	46·82	18·73
8	27·428	3½	260·08	...	158·12	39·53	15·81
9	30·857	3½	292·59	...	134·40	33·60	13·44

Solid Uniform Cylindrical Pillars of Wrought Iron, both Ends being Flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	Diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formula, $W=133{\cdot}75\frac{D^{3\cdot55}}{L^2}$.	Calculated breaking weight in tons from formula, $Y=\frac{bc}{b+\frac{3}{4}c}$.	Safe weight in tons.	Safe weight, if irregularly fixed, in tons.
10	34·285	3½	325·10	114·21	...	28·55	11·42
11	37·714	3½	357·61	94·39	...	23·59	9·43
12	41·142	3½	390·12	79·31	...	19·82	7·93
13	44·571	3½	422·69	67·58	...	16·89	6·75
14	48	3½	455·14	58·27	...	14·56	5·82
15	51·428	3½	487·65	50·76	...	12·69	5·07
16	54·857	3½	520·16	44·61	...	11·15	4·46
17	58·284	3½	552·67	39·52	...	9·88	3·95
18	61·714	3½	585·18	35·25	...	8·81	3·52
19	65·142	3½	617·69	31·63	...	7·90	3·16
20	68·571	3½	650·20	28·55	...	7·13	2·85
5	15	4	212·30	...	377·93	94·48	37·79
6	18	4	254·76	...	323·04	80·76	32·30
7	21	4	297·22	...	275·71	68·92	27·57
8	24	4	339·68	...	235·84	58·96	23·58
9	27	4	382·14	...	202·63	50·65	20·26
10	30	4	424·60	...	175·08	43·77	17·50
11	33	4	467·06	151·64	...	37·94	15·16
12	36	4	509·52	127·42	...	31·85	12·74
13	39	4	551·98	108·57	...	27·14	10·85
14	42	4	594·44	93·61	...	23·40	9·36
15	45	4	636·90	81·55	...	20·38	8·15
16	48	4	679·36	71·67	...	17·91	7·16
17	51	4	721·82	63·49	...	15·87	6·34
18	54	4	764·28	56.63	...	14·15	5·66
19	57	4	806·74	50·82	...	12·70	5·08
20	60	4	849·20	45·87	...	11·46	4·58
5	13·333	4½	268·70	...	511·27	127·81	51·12
6	16	4½	322·44	...	444·07	111·01	44·40
7	18·666	4½	376·18	...	384·36	96·09	38·43
8	21·333	4½	429·92	...	332·74	83·18	33·27
9	24	4½	483·66	...	288·78	72·19	28·87
10	26·666	4½	537·40	...	251·63	62·90	25·16
11	29·333	4½	591·14	...	220·30	55·07	22·03
12	32	4½	644·88	193·56	...	48·39	19·35
13	34·666	4½	698·62	164·93	...	41·23	16·49
14	37·333	4½	752·36	142·21	...	35·55	14·22
15	40	4½	806·10	123·88	...	30·97	12·38
16	42·666	4½	859·84	108·88	...	27·22	10·88
17	45·333	4½	913·58	96·44	...	24·11	9·64
18	48	4½	967·32	86·02	...	21·50	8·60
19	50·666	4½	1021·06	77·21	...	19·30	7·72
20	53·333	4½	1074·80	69·68	...	17·42	6·96
5	12	5	331·75	...	665·71	166·42	66·57
6	14·4	5	398·10	...	586·24	146·56	58·62
7	16·8	5	464·45	...	513·76	128·44	51·37
8	19·2	5	530·80	...	449·62	112·40	44·96
9	21·6	5	597·15	...	393·89	98·47	39·38

Solid Uniform Cylindrical Pillars of Wrought Iron, both Ends being Flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	Diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formula, $W=133{\cdot}75\frac{D^{3{\cdot}55}}{L^2}$.	Calculated breaking weight in tons from formula, $Y=\frac{b\ c}{b+\frac{3}{4}c}$.	Safe weight in tons.	Safe weight, if irregularly fixed, in tons.
10	24	5	663·50	......	345·96	86·49	34·59
11	26·4	5	729·85	......	304·95	76·23	30·49
12	28·8	5	796·20	......	269·90	67·47	26·99
13	31·2	5	862·55	239·74	......	59·93	23·97
14	33·6	5	928·90	206·71	......	51·67	20·67
15	36	5	995·25	180·07	......	45·01	18·00
16	38·4	5	1061·60	158·26	......	39·56	15·82
17	40·8	5	1127·95	140·19	......	35·04	14·01
18	43·2	5	1194·30	125·05	......	31·26	12·50
19	45·6	5	1260·65	112·23	......	28·05	11·22
20	48	5	1327·00	101·29	......	25·32	10·12
5	10	6	477·70	......	1037·28	259·32	103·72
6	12	6	573·24	......	934·01	233·50	93·40
7	14	6	668·78	......	835·68	208·92	83·56
8	16	6	764·32	......	745·16	186·29	74·51
9	18	6	859·86	......	663·69	165·92	66·36
10	20	6	955·40	......	591·42	147·85	59·14
11	22	6	1050·94	......	527·89	131·97	52·78
12	24	6	1146·48	......	472·31	118·07	47·23
13	26	6	1242·02	......	423·82	105·95	42·38
14	28	6	1337·56	......	381·51	95·37	38·15
15	30	6	1433·10	343·98	......	85·99	34·39
16	32	6	1528·64	302·33	......	75·58	30·23
17	34	6	1624·18	267·81	......	66·95	26·78
18	36	6	1719·72	238·88	......	59·72	23·88
19	38	6	1815·26	214·39	......	53·59	21·43
20	40	6	1910·80	193·52	......	48·38	19·35

Hollow Uniform Cylindrical Pillars of Cast Iron, both Ends being Flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formula, $b=44{\cdot}34\frac{D^{3{\cdot}55}-d^{3{\cdot}55}}{L^{1{\cdot}7}}$ $Y=\frac{b\ c}{b+\frac{3}{4}c}$	Safe weight in tons.	Safe weight, if irregularly fixed, in tons.
8	8	12	$10\frac{1}{2}$	663·40	1003·66	250·91	100·36
9	9	12	$10\frac{1}{2}$	746·32	955·46	238·86	95·54
10	10	12	$10\frac{1}{2}$	829·25	908·30	227·07	90·83
11	11	12	$10\frac{1}{2}$	912·17	862·65	215·66	86·26
12	12	12	$10\frac{1}{2}$	995·10	818·78	204·69	81·87
13	13	12	$10\frac{1}{2}$	1078·02	766·89	194·22	77·68
14	14	12	$10\frac{1}{2}$	1160·95	737·10	184·27	73·71
15	15	12	$10\frac{1}{2}$	1243·87	699·44	174·86	69·94
16	16	12	$10\frac{1}{2}$	1326·80	663·89	165·97	66·38

(To be continued.)

ROYAL INSTITUTION OF GREAT BRITAIN.

ON THE IRON WALLS OF OLD ENGLAND.

By John Scott Russell, Esq., F.R.S.

It was not the first time the speaker had been allowed the honour of expounding such truths as had been the object of his special study, but he had never treated on one of so great national importance. He was somewhat rash, perhaps, in accepting from the managers the title of this address,—rash because the subject was then in a state of transition. It was even worse now, for it had come to what geologists had called a "slip;" he might almost say he found himself at "fault." What he had to say now was as different as possible from what he should have said when he made the promise. Six or eight months ago he should have met here a formidable phalanx of adversaries—amongst them nearly all the naval officers—arrayed against him as the advocate of iron ships of war, and he should have had to argue every point as he proceeded. But unfortunately now we were all on one side; the pugilistic encounter which might then have entertained his audience could not come off. Twelve months ago he had written a pamphlet showing that the end of wooden men-of-war was at hand, and that it was a sin and a shame to send our sailors to sea in them; but the authorities of that day brought their guns to bear upon him and completely demolished him. Since then, however, he had got up again; and his heterodoxy had become orthodoxy, and he thought there would be no opponent of "iron walls" for the future. About the beginning of the year we were on the eve of war with a people who, whatever their faults, have never hesitated to adopt for war the fittest weapons—who, long before rifles were introduced into our army, were celebrated for their use of them and for their manufacture,—to whom we are indebted for the revolvers we found so useful in India, and which, whether they invented them or not, they brought to perfection. That people excelled also in ships; for while the English people, priding themselves on the beautiful "wave lines" on which their fast steamers were built, were slow to perceive the advantage of the same lines for sailing ships; the Americans adopted them for their sailing vessels, and came over and beat our fleetest yachts in our own waters. It was the Americans, too, who first built ships of large size, and carried off our best freights in their large wave-line clippers. When going to war with such a powerful nation it became necessary to take stock of our fighting material. The government did take stock of your fleet and the extent of your navy, fit for a naval battle, at the beginning of the present year—as announced in a powerful leader in the *Times*—was one ship of the line. At the present moment we have two ships of the line fit for service, the *Warrior* and the *Black Prince*, and no more. This serious point is no longer a matter of speculation. It is now universally accepted as a fact,—and accepted by us on a very small naval engagement in American waters, the contest of the *Merrimac* and *Monitor*,—that an iron vessel of war is better than a wooden one; while the battle of the *Merrimac* with the *Congress* and *Cumberland* has settled the point in dispute eight or nine months ago, viz., that a wooden vessel could not sustain the attack of a ship of war in iron armour. Sir John Hay, the chairman of the naval commission, is quoted in an excellent article in the *Quarterly Review*, as using this expression,—"The man who goes into action in a wooden vessel is a fool, and the man who sends him there is a villain."

Let us now inquire how this revolution has come about. How is it that our brave sailors ought no longer to face our enemies from behind our wooden walls? This revolution has been chiefly brought about by the introduction in artillery of horizontal shell-firing. A certain General Paixhans, a Frenchman, contributed more than anyone else to this result. He made cannon of eight to ten inches bore, by which explosive shells—which previously had been fired up in the air and had to come down again upon their object—could then be fired straight at the mark, especially at a wooden ship, which was as good a target as an enemy could possibly desire. This horizontal firing was for a long time a favourite idea with artillerists; but they had very little opportunity in trying it in practical war. Sir Howard Douglas, speaking of its effects, says, "A shell exploding between decks acts in every direction; under the deck it would blow up all above it; on deck it would make a prodigous breach below it, at the same time that it would act laterally." The shell which accidentally exploded in the *Medea* on the lower deck, killed the bombardier and several of the crew, knocked down all the bulkheads, and threw the whole squadron into consternation; and the like effect was to be expected from an enemy's shell lodged before its explosion had taken place. The first experiment on a large scale in actual war was at the commencement of the Russian war. The Russian fleet, sneaking about the Black Sea, put into Sinope, and in a very short space of one morning sank and burnt the Turkish squadron. This battle was the entire effect of horizontal shell-firing. The true nature of this horizontal fire has had another illustration. You were all astonished, and wanted to know why Sir Charles Napier did not take Cronstadt, and that our other fleet did not take Sebastopol. It was well known to professional men then why we did not, and there is now no reason why the secret should be kept, Our enemies know it, so why not our friends? Our sailors were not fools enough to stand to their guns in wooden ships exposed to horizontal shell-firing. The speaker had read a letter from Lord Dundonald, one of the bravest sailors that ever trod the deck, written by him to Napier off Cronstadt, in which he expresses the greatest apprehension that Sir Charles would be goaded on to try the attack with what he called combustible ships. We tried Sebastopol—or rather we tried to "make-believe." We drew up our fleet a great way off, and one or two brave sailors did go in closer. But the Russian gunners were trained to horizontal shell-firing, and they soon found out it was best to be farther off. The admiral was to be considered the wisest man on board the fleet, for he anchored his ship the farthest off. Those ships that ventured in were rendered by these shells incapable of continuing the action, and it is not now considered a disgrace to those sailors to say that after three shells had exploded in one ship it was not possible to find men "fools" enough to stand to the guns. "Now, you know why we did not take Cronstadt, and why you did not know it sooner was, because the Government did not wish you should fail to believe in the wooden walls. At last, however, the *Monitor* and *Merrimac* have let out the secret, and I am here to tell you the whole truth." It need not be said that those shells at Sinope and Sebastopol were not the perfect weapons we have now—the Armstrong shells are much more precise, and will scatter greater destruction around them. How much more I may not tell.

Attention has, therefore, since 1854 till now, been strongly directed to inventions for protecting ships from the effect of shells—and shot also, but chiefly shells. Men will stand against shot, but not against shells; they will run the risk of being hit, but will not face the certainty of being blown up. The invention of iron armour took place fifty or sixty years ago. He was not prepared to name the first inventor; but long before we thought of using it in our navy, Mr. R. L. Stevens, a celebrated engineer, of New York, the builder of some of the fastest steam vessels on the Hudson, was, he thought, the inventor. Certainly Mr. Stevens, between 1845 and 1850, gave him a full account of experiments made in America, partly at his own, and partly at the State's expense, and found that six inches thickness of iron-plate armour was sufficient to resist every shot and shell of that day. In 1845, he (Mr. Stevens) proposed to the American Government to construct an iron-plated ship, and in 1854 the ship was begun. This ship is in progress, but not yet finished. Mr. Stevens is therefore the inventor of iron-armour; but no doubt the first man who applied it practically for warfare was the Emperor of the French. In 1854 he engaged in the Russian war, and being a great artillerist, he felt deeply what his fleet could not do in the Black Sea, and what we could not do in the Baltic, and so he put his wise head to work to find out what could be done. In 1854, the Emperor built some floating batteries—four or five; we simply took his design, and made five or six.

He had called the introduction of iron-armour ships, Stevens's and the Emperor's; but something he laid claim to for ourselves. Stevens used thin flat plates one over the other; but Mr. Lloyd, of the Admiralty, being consulted at that time, did express his opinion that solid 4½in. plates would be more effectual than the six inches of thickness in a congeries of plates. Mr. Lloyd has some of the merit as well as the Emperor for the adoption of this kind of armour. The speaker exhibited a model of the first iron batteries. The form, he said, was not very handsome; in short, they were not only not good sea-boats, but in a sea good for nothing. They did, however, in smooth water, some good work; at least three of the French Emperor's did. We never got so far. They went to the Black Sea—to Kinburn; and when they came back they were covered with marks of shot, but not one of them was seriously damaged. This proved the value of these coated vessels, and so convinced the Emperor, that he wisely determined the fleet of France in future should be an iron fleet. We all know with what decision, what success, what economy he has carried that idea out. "I have here," said the speaker, "the means of showing you what this armour is. Now to tell the secret of the efficacy of an armour plate. First, as a matter of fact, it stops the shot, as an anvil stops a hammer, and stops it outside the ship; and so, therefore, the armour acts practically as an anvil. When these plates were made they were made to resist 8-pounders, and 4½in. thickness was ample; but now they were firing shot very much larger. When a round ball, or a round shell, strikes the iron plate, the first thing done is, that it stops the bit of the ball that first touches the armour; next, the bits round it rush on until they too get stopped by the armour; and so this little (!) ball makes a dent for itself; the remainder of the crushed ball seems, as Mr. Faraday says, to be 'squermed' out of shape. I stole the word, it is so capitally expressive. The shape is not like the original ball,—it is an entirely new form altogether. I call it Faraday's squerm. But we have not the full weight of mettle here. We have only a part of the shot left, the remainder is dispersed in numerous fragments. This is all that remains—a beautiful smooth, polished cone; the rest has gone everywhere. What meanwhile has happened to the armour? The plate first gets a dent; if Sir William Armstrong hits it twice in the same place the dent gets deeper; and if he hits it again in the same hollow, as he so maliciously does, the dent parts company with the plate and starts on a voyage of exploration for itself. But if this ball (150 pounder) were used, I am sure that at the first hit it would take a piece of its own size away with it. Now, if this occurs with a solid shot, what would happen with a hollow ball made to explode, and fired at the ship? Fortunately we know what would happen. We have seen it fired, and it not only got smashed to pieces, but it forgot to explode, and the only excuse that can be made for this is that it had not time to do so. I do not know if you know what takes place inside of a gun; but artillerists know it takes some 4 or 5-1000ths of a second for the explosion to go from one end of the charge to the other. Explosion in a shell also takes time, and what happens with the shell striking the armour is that it gets shattered to pieces and the powder scattered about before it has time to explode; and this not only with four-inch iron, but with plates a great deal thinner." This power of annihilating shell is one of the advantages which iron bestows on a ship, and for which wood is powerless; and upon this very fortunate fact the new principle of naval construction is based, for whatever armour will do against shot, it will infallibly keep out the shell. What kind of armour is best against shell and what against shot is still a subject of discussion. The most important results were being worked out by the committee on iron plates as to the best adaptation of armour for the purposes we want.

To the speaker's mind, the best kind of armour and the best kind of ship was that combined in the *Warrior*. There was one gun-deck, in which a battery of guns of the heaviest calibre was placed, and that battery was entirely covered with iron plates, backed with eighteen inches of wood lying between them and the iron skin of the ship. A great effort was now being made to get rid of this wooden backing, which was liable to rot and contributed no strength to the vessel. When an effective iron backing was constructed, the last improvement would be got that was looked for in the construction of an armour-plated ship. He then explained what were the great difficulties to contend with in the construction of the new fleet. There was no difficulty in the armour; we know we can keep out the shell and the shot; for if Sir William Armstrong pushes us too hard, we know how much more iron will keep him out. What we have to do that is difficult, is to build a ship that will not merely keep out shell and resist shot, but also possess speed with good sea going qualities—a monstrous difficulty. The problem was purely one of naval architecture. The difficulty arose in this way: the iron armour placed a very great weight in a very bad place; it tended to make the ship top-heavy, and "crank." Now such a vessel rolls, and a very heavy roll might roll her upside under—an event to be avoided as long as possible. The puzzle was, therefore, to make a stable ship that should stand under this great top-weight of armour, and be a good sea-going vessel. The first iron batteries were totally devoid of this quality. They were not ship-shape, but sea-chest shape. Those we sent out to the Black Sea—and one was under a very good captain—never got there, or, if they did, they never did anything but come back again. He referred to them because they were a class of ships that were now being agitated for. The question was now being entertained, in the highest quarters, as to whether our new fleet of vessels should be fit for long voyages and able to encounter heavy seas, such as were necessary for the protec- of our colonies and commerce; or whether they should be made unseaworthy slow vessels, incapable of following the enemy if he ran away, still less of catching him. They were only adapted for staying at home; and, in order to hurt the enemy, the enemy must come to them to be hurt.

Mr. Scott Russell then went into the details of what he advocated as the best class of shot-proof vessel—the improved *Warrior* class. This class was 58ft. wide, 400ft. long, and more than 7,000 tons in size, and cost, fully armed and fitted for sea, not much short of half a million. The distinguishing quality of the *Warrior* was, that she had proved a very excellent sea-going vessel. He was happy to say that four more of this class were building, and two already built. Her armour consisted of 4½-in. iron plates, and extended over the whole length to be protected, and came down about 5ft. below water. This arrangement of armour was such, that its centre of gravity was brought to 6ft. above the water. Now, for a comfortable ship it was held, that the centre of gravity should be near the water-line, and this was therefore a problem of some difficulty; but the ship had turned out, nevertheless, a faster man-of-war than any other, and also an easy, good sea-boat.

This difficulty of top-weight was got over, in Stevens's early armour vessel, by a different method from the *Warrior*. Giving up the problem of a sea-going ship, he took to smooth water, and built his vessel much on the mid-ship section of a London barge; the sides sloped outwards under water, and sloped inwards above water, so as to form a narrow upper deck, carrying seven guns, the angles of the sides being usually a little above water, but capable of being sunk to the level of it during action. So little, however, was she adapted for a sea-going ship, that a false side was obliged to be put up to make her at all seaworthy; and he would only ask our naval officers if such vessels were fit to protect our trade and our possessions on the wide ocean? The Stevens battery is as long as the *Warrior*, is to have as high a speed, and carry a central, shot-proof platform, with seven large guns mounted on turn-tables, and worked below decks by machinery. The guns were pointed downwards for loading, and were returned to their positions, and worked thus by men and machinery below the iron deck, and wholly under cover. There were points of this battery so like some recently proposed to be constructed in this country, that it was difficult to conceive the secret had not transpired. This battery was begun in 1854, and is now about to be finished. The Stevens battery is a favourable specimen of a ship built for action in the smooth waters of America. But it is our duty to construct quite a different class of ships, and the *Warrior* is the type of that class. No one can help seeing the superiority, for our uses, of having such vessels only as can go anywhere and do anything, and are faster, more powerful, more enduring, and more seaworthy than any other steam-ship of any other navy.

The *Merrimac*, one of the most beautiful of the American frigates that first set the pattern which has been followed in so many of our own noble vessels, was cut down by the Southerners, and said to have been covered with rails; but, in reality, covered with one coating of plates, six inches broad, and an inch and a half thick, laid diagonally, and a second coating two inches and a half thick in an opposite direction, over a backing of wood. By this simple means she was converted into the formidable vessel that attacked so victoriously the *Congress* and *Cumberland*, and disabling them by the shells poured in, as much as by her power as a ram, destroyed them in a short encounter. The *Monitor*, improvised by Ericsson in three months, is 160ft. long, 40ft. wide, and 6ft. deep, and below this upper body is another propelled by steam. She carries a revolving iron tower of six inches thick, containing two heavy guns. Now the upshot of the contest of these two vessels has decided two points for us. 1. That wooden men-of-war are worthless in presence of iron-coated ships; for the *Merrimac* sank two of them without the slightest difficulty. 2. That wooden ships, even coated with iron, are ineffective against iron ships coated with iron armour; for after a long contest the *Merrimac* failed to injure the *Monitor*, and had to retire.

Captain Coles's shield vessel was next described. His plans were submitted to the Admiralty in 1859, long prior to the construction of Ericsson's battery. These shields and the *Monitor's* are much alike in principle, but Captain Coles's vessel is a far better sea-boat than the *Monitor*, and carries twelve guns instead of one, as in that vessel. Coles's shield has a conical roof, and carries one or two Armstrong 100-pounders fixed in slides, which are parts of the interior of the shield, that moves round on a central pivot, and the men working the guns are turned round in it entirely under cover. The construction of the shield ship designed by the Admiralty is altogether better than the *Monitor's*. The speaker does not wish, however, to see our war-ships replaced by vessels of this class, but by those worthy of ourselves—a fleet of *Warriors*.

Mr. Scott Rusell hoped he had now shown how it had come to pass that we had got a useless navy of wooden ships, and only two iron ones ready for service. There were two more nearly ready, not of the *Warrior* class, about which the less he said the more he should praise them. The Government had, however, laid down the lines for four more enlarged *Warriors*, and this was an atonement for the two he would not say anything about. We must then look to a long time before we shall have more than two ships of the "Warrior" class. He considered this delay deplorable. When the Duke of Somerset was asked in the House why he had not sooner built more iron ships, he said, "The House of Commons had been in no particular hurry." And when he was asked about his tardy adoption of Captain Coles's plan, he replied, "He delayed until he had consulted the House of Commons about it." Now the serious difficulty was this, while the French Emperor had been making rapid use of his experience of iron batteries, we had not. In 1854, his were at Kinburn and up to their work. In 1856, Captain Halsted made application to have one of our batteries made the subject of experiment, in order to see if she would resist shot and shell, with a view then to make an iron navy. The Admiralty did have the *Trusty* made ready; and had her out. Then they took fright and sent her back again; and so we lost two years' start. He would now mention a fact of which there was no longer any grounds for concealment. In 1855 he submitted to the surveyor of the navy a drawing and model of the *Warrior* class of ships. That model was now on the table, and exhibited all the important features of construction of the *Warrior* class. But the Admiralty delayed the construction of the first ship of the class till 1859; and so we lost our just claim to the original design of iron ships in armour, with sea-going qualities and speed united. It was Sir John Pakington who, in 1858, first ordered an iron fleet to be commenced, on a joint design of himself, Mr. Scott Russell, and the Surveyor of the Navy. But the French Emperor had already commenced the *Gloire;* so that instead of being, as we might have been, three years ahead of the French Emperor, our delay had given him the lead, and deprived us of our true priority. He concluded by expressing a hope, that the delays and doubts of the Admiralty might now end; that a fleet of enlarged *Warriors* would speedily be constructed, fit to carry English sailors on every sea where our colonies and commerce required their protection; and that no more of our time or money would be wasted in the consideration or construction of inferior classes of vessel, unfit for ocean navigation, and good only to stay at home until the enemy should choose to come and be hurt. We had now proved our *Warrior* class to be sound, wholesome sea-going ships, and to be unparalleled in speed. Of course, improvements would in future be made, and changes introduced. But when our constructions truly embodied the best knowledge and experience of their time, our responsibility was fulfilled, and at present we know of no match for the enlarged *Warrior* class of 7000 tons, and therefore there can no longer remain any excuse for continuing in our present inefficient condition.

ON THE ABSORPTION AND RADIATION OF HEAT BY GASEOUS MATTER.

BY JOHN TYNDALL, F.R.S.

Resuming with a new apparatus his experiments on the influence of chemical combination on the absorption and radiation of heat by gases, the speaker, in the investigation of which the evening's discourse would be a *résumé*, first examines the deportment of chlorine as compared with hydrochloric acid, and of bromine as compared with hydrobromic acid, and finds that the act of combination which in each of these two cases notably diminishes the density of the gas and renders the coloured gas perfctly transparent to light, renders it more opaque for obscure heat. He also draws attention to the fact that sulphur, which is partially opaque to light, is transparent to 54 per cent. of the rays issuing from a source of 100 C, while its compound, heavy spar, which is sensibly transparent to light, is quite opaque to the rays issuing from a source of 100 C. He demonstrates, in confirmation of Melloni, the transparency of lampblack in thin layers; but shows how irreconcilable its deportment to radient heat is with the idea generally prevalent at the present day, that lampblack absorbs heat of all kinds with the same intensity.

All his exeperiments with gases have been repeated with a different source of heat, and he finds the result still more pronounced than formerly, that the compound gases far transcend the elementary ones in absorptive power. Taking air as unity, ammonia, at 30 inches tension, is 1195, this latter figure representing all the heat that issued from the source. A layer of ammonia, 3 feet long, is perfectly black to heat emanating from an obscure source. The coloured gases, chlorine and bromine, though much superior in absorptive power to the transparent elementary gases are exceeded in this respect by every compound gas that has been hitherto examined. When, instead of tensions of 30 inches, we compare tensions of 1 inch, the differencies between the gases come out still more strikingly. At this tension, for example, the absorption of sulphurous acid is eight thousand times that of air.

The speaker also referred to a new and extensive series of experiments on the absorption of radiant heat by vapours. The least energetic, as before, he finds to be bisulphide of carbon; the most energetic, boracic ether. He shows that the absorption of the latter vapour (which is quite transparent) at 0·1 of an inch of tension is 600 times the absorption of the densely coloured vapour of bromine, while in all probability it is 186,000 times that of air.

The speaker was led by a series of perplexing experiments, which are fully described in a memoir recently presented to the Royal Society, to the solution of the following remarkable and at first sight utterly paradoxical problem:—"To determine the absorption and radiation of a gas or vapour without any source of heat external to the gaseous boby itself."

When air enters a vacuum it is heated by the stoppage of its motion; when a vessel containing air is exhausted by an air-pump, chilling is produced by the application of a portion of the heat to the air to generate *vis viva*. Let us call the heating in the first case dynamic heat, and the chilling in the second case dynamic chilling. Let us further call the radiation of a gas which has been heated dynamically, dynamic radiation, and the absorption of a gas which has been chilled dynamically, dynamic absorption. Placing a thermo-electric pile at the end of his experimental tube, the latter being exhausted, the gas to be examined is permitted to enter the tube; the gas is heated, and if it possess any sensible radiative power, the pile will receive its radiation, and the galvanometer connected with the pile will declare it.

Proceeding in this way with gases, Professor Tynkall found that the radiation thus manifested, and which was sometimes so intense as to urge the needle of the galvanometer through an arc of more than sixty degrees, followed the exact order of the absorptions which he had already determined. After the heat of the radiating column of gas had wasted itself, the air-pump was worked at a certain rate, the rarefied gas within the tube became chilled, and the face of the pile turned towards the chilled gas became correspondingly lowered in temperature. The dynamic absorptions of various gases were thus determined, and they were found to go strictly hand-in-hand with the dynamic radiation.

In the case of vapours the following method was pursued. A quantity of the vapour sufficient to depress the mercury column 0·5 of an inch was admitted into the tube, and this was heated dynamically by allowing dry air to enter till the tube was filled. The radiation of the vapours thus determined followed exactly the same order as the absorption which had already been measured. The dynamic absorption of the vapour was obtained by pumping out in the manner just described, and it was found to follow the same order as the dynamic radiation. In these experiments the air bore the the same relationship to the vapour that a polished silver surface does to a coat of varnish laid over it. Neither the silver nor the air, both of which are elements or mixtures of elements, possesses the power of agitating in any marked degree the luminiferous ether. But the motion of the silver being communicated to the varnish, and the motion of the air being communicated to the varnish, molecules are agitated which have the power of disturbing, in a very considerable degree, the ether in which they swing.

The speaker finds by strict experiments that the dynamic radiation of an amount of boraic ether vapour, possessing a tension of only $\frac{1}{10125000000}$th of an atmosphere is easily measurable. He also shows and explains the fact that with a tube 33 inches long, the dynamic radiation of acetic ether considerably exceeds that of olefiant gas; while in a tube 3 inches long, the dynamic radiation of olefiant gas considerably exceeds that of the ether. Aqueous vapour has been subjected to a special examination, and Professor Tyndall finds it a common fact for the aqueous vapour contained in the atmosphere to exercise 60 times the absorption of the air itself. The further he has pursued his attempts to obtain perfectly pure and dry air, the more has the air approached the character of a vacuum. He further points to the possibility of determining the temperature of space by direct experiment.

Scents of various kinds have been examined. Dry air was passed over bibulous paper moistened by the essential oils, and carried into the experimental tube. Small as the amount of matter here entering the tube is known to be, it was found that the absorption of radiant heat by those odours varies from 30 times to 372 times that of the air which formed the vehicle. The speaker remarked that the absorption of terrestrial rays by the odour of a flower-bed may exceed in amount that of the entire oxygen and nitrogen of the atmosphere above the bed.

Ozone has also been subjected to examination. The substance was obtained by the electrolysis of water, and from decomposing cells containing electrodes of various sizes. Calling the action of the ordinary oxygen, which entered the experimental tube with the ozone unity, the absorption of the ozone itself was in six different experiments,—21, 36, 47, 65, 85, 136. The augmenting action of the ozone accompanied the diminution of the size of the electrodes used in the decomposing cells. Professor Tyndall points out the perfect correspondence of these last results with those of M. Meidinger by a totally different method of experiment.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

ON THE EMPLOYMENT OF GALVANIZED IRON FOR ARMOUR-PLATED SHIPS.

BY DR. CALVERT.

The author stated that no doubt many gentlemen present were acquainted with the fact that he had been for some time past engaged in ascertaining the chemical composition of various woods employed and susceptible of being employed in the navy. On a recent visit to one of the dockyards he found that while the armour-plates were fixed against a layer of teak, the ribs of the ship were of oak, and that the iron bolts which were to fasten the plates were to pass through the oak ribs. It occurred to him that the inconvenience which would probably result from the action of the oak upon the iron might be obviated by substituting galvanized iron bolts for those now in use, and he therefore instituted a series of experiments, the results of which he had great pleasure in laying before the meeting.

The first series of experiments consisted in having driven through large pieces of oak, bolts and screws of iron and galvanized iron, prepared by his friends, Messrs. Richard Johnson and Brother, of Dale-street, Manchester, which were then immersed in salt and sea water for the last three months. The results clearly showed, first, that the friction did not remove the zinc from the galvanized iron; secondly, that the oak and galvanized bolts were unchanged; whilst in the case of the iron bolts, they were much rusted, and the pieces of oak had become quite black by the formation of tannate and gallate of peroxide of iron. During the experiments the waters were changed every week, and those containing the galvanized iron appeared unchanged, whilst in the case of the iron, they had a dark blue-black appearance, owing to the formation of gallate and tannate of iron.

In order to ascertain the comparative action of soft and salt water upon iron and galvanized iron when in contact with oak under identical circumstances, he made the following series of experiments.

Plates of galvanized iron having 18 inches of surface, lost during three months the following weights:—

	SOFT WATER.	SEA WATER.
Plate No. 1	0·10 grains	——
„ No. 2	0·11 „	——
„ No. 3		0·095 grains.
„ No. 4		0·090 „

Similar plates of iron lost during the same time:—

	SOFT WATER.	SEA WATER.
Plate No. 1	1·23 grains	——
„ No. 2	1·52 „	——
„ No. 3		2·40 grains.
„ No. 4		2·38 „

There can therefore be no doubt that galvanized iron offers great advantages, the action of water on it being less than a tenth of the same action on ordinary iron. As there is no doubt that iron when galvanized is in the most favourable electrical condition to resist the action of oxygen, being in an electro-negative condition, it follows that in all probability the use of galvanized iron would be very advantageous in armour-plated and other iron ships. The author hoped that Government and other large ship-builders would avail themselves of this suggestion, and make experiments on a large scale to verify the results he had obtained.

ON THE EFFECT OF INCREASED TEMPERATURE UPON THE NATURE OF THE LIGHT EMITTED BY THE VAPOUR OF CERTAIN METALS OR METALLIC COMPOUNDS.

BY PROFESSOR ROSCOE.

In a letter communicated to the *Philosophical Magazine* for January last, we stated that in examining, with Steinheils's form of Kirchoff and Bunsen's apparatus, the spectra produced by passing the induction spark over beads of the chlorides and carbonates of lithium and strontium, we had observed an apparent coincidence between the blue lithium line, which is seen only when the vapour of this metal is intensely heated, and the common blue strontium line called Sr δ. We further stated that on investigating the subject more narrowly by the application of several prisms and a magnifying power of 40, we came to the conclusion that the lithium blue line was somewhat more refrangible than the strontium δ, but that two other more refrangible lines were observed to be coincident in both spectra. Having constructed a much more perfect instrument than we at that time possessed, we are now able to express a definite opinion on the subject, and beg to lay a short notice of our observations before the Society. Our instrument is in all essential respects similar to the magnificent apparatus employed by Kirchhoff in his recent investigations on the solar spectrum and the spectra of the chemical elements. It consists of a horizontal plane cast-iron plate, upon which three of Steinheil's Munic prisms, each having a refracting angle of 60°, are placed; and of two tubes fixed into the plate, one being a telescope having a magnifying power of 40, moveable with a slow-motion screw about a vertical axis placed in the centre of the plate, and the other being a tube carrying at one end the slit, furnished with micrometer screw, through which the beam of light passed, and at the other end an object-glass for the purpose of rendering the rays parallel. The luminous vapours of the metals under examination were obtained by placing a bead of the chloride or other salt of the metal on a platinum wire, between two platinum electrodes, from which the spark of a powerful induction coil could be passed. In order to obtain a more intense, and therefore a hotter spark than can be got from the coil alone, the coatings of a Leyden jar were placed in connection with electrodes of the secondary current respectively. When this arrangement was carefully adjusted, the two yellow sodium lines were observed to be separated by an apparent interval of two millimetres, as seen at the least distance of distinct vision.

The position of the blue line, or rather blue band of lithium, was then determined with reference to the fixed reflecting scale of Steinheil's instrument, by volatising the carbonate of lithium in the first place on a platinum wire between platinum electrodes, and secondly on a copper wire between copper electrodes. A bead of pure chloride of strontium was then placed on new platinum and copper wires between two new platinum and copper electrodes, and the position of the blue line Sr δ read off upon the same fixed scale; a difference of one division on the scale was seen to exist between the positions of the two lines, the lithium line being the more refrangible. The salts of the two metals were then placed between the poles at the same time, and both the blue lines were simultaneously seen, separated by a space about equal to that separating the two sodium lines. When experimenting with this complete instrument, we were unable to observe any other blue lines in the pure lithium spectrum than the one above referred to; we have, however, noticed the formation of four new violet lines in the intense strontium spectrum, and we now believe that the other two lithium lines mentioned in our letter to the *Philosophical Magazine* are caused by the presence of the most minute trace of strontium floating in the atmosphere, and derived from a previous experiment. We have convinced ourselves by numerous observations that the currents of air caused by the rapid passage of the electric spark between the electrodes are sufficient to carry over to a second set of electrodes placed at the distance of a few inches, a very perceptible quantity of the materials undergoing volatilisation. The greatest precautions must hence be taken when the spectra of two metals have to be compared; and no separate observations of the two spectra can be relied upon, unless one is made a considerable space of time after the other, and unless all the electrodes which have been once used are exchanged for new ones.

Kirchhoff, in his interesting memoir on the Solar Spectrum and the spectra of the chemical elements,* noticed in the case of the calcium spectrum, that bright lines which were invisible at the temperature of the coal gas flame became visible when the temperature of the incasdescent vapour reached that of the intense electric spark.

We have confirmed this observation of Kirchhoff's, and have extended it, inasmuch as we, in the first place, have noticed that a similar change occurs in the spectra of Strontium and Barium; and, in the second place, that only new lines appear at the high temperature of the intense spark, but that the broad bands characteristic of the metal or metallic compound at the low temperature of the flame or weak spark, totally disappear at the higher temperature. The new bright lines which supply the part of the broad bands are generally not coincident with any part of the band, sometimes being less and sometimes more refrangible. Thus the broad band in the flame-spectrum of calcium named Ca β, is replaced in the spectrum of the intense calcium-spark by five fine green lines, all of which are less refrangible than any part of the band Ca β; whilst in place of the red or orange band Ca α, three more refrangible red or organge lines are seen. The total disappearance in the spark of a well defined yellow band seen in the calcium spectrum at the lower temperature, was strikingly evident. We have assured ourselves by repeated observations that, in like manner, the broad bands produced in the flame-spectra of strontium and barium compounds, and especially Sr α, Sr β, Sr γ, Ba α, Ba β, Ba γ, Ba δ, Ba ε, Ba η, disappear entirely in the spectra of the intense spark, and that new bright non-coincident lines appear. The blue Sr δ line does not alter either in intensity or in position with the alterations of temperature thus effected, but, as has already been stated, four new violet lines appear in the spectrum of strontium at the higher temperature.

If, in the present incomplete condition of this most interesting branch of inquiry we may be allowed to express an opinion as to the possible cause of the phenomenon of the disappearance of the broad bands and the production of the bright lines, we would suggest, that at the lower temperature of the flame or weak spark, the spectrum observed is produced by the glowing vapour of some compound, probably the oxide, of the difficulty reducible metal; whereas, at the enormously high temperature of the intense electric spark these compounds are split up, and thus the true spectrum of the metal is obtained.

In conclusion, we may add that in none of the spectra of the more easily reducible alkaline metals (potassium, sodium, lithium) can any deviation or disappearance of the maxima of light be noticed on change of temperature.

ON THE PROBABLE CAUSE OF ELECTRICAL STORMS.

BY DR. JOULE.

The very close correspondence between the theoretical rate of cooling in ascending, and the actual, indicates a rapid transmission of the atmosphere from above to below, and *vice versa*, continually going on. We may believe that during thunderstorms this interchange goes on with much greater than ordinary rapidity. At a considerable distance from the thundercloud, where the atmosphere is free from cloud, the air descends, acquiring temperature according to the law of convective equilibrium in dry air. The air then traverses the ground towards the region where the storm is raging, acquiring moisture as it proceeds, but probably without much diminution of temperature, on account of the heated ground making up for the cold of evaporation. Arrived under the thundercloud, the air rises, losing temperature, but at a diminished rate, owing to the condensation of its vapour to form part of the immense cumulus cloud which overcasts the sky on these occasions. The upward current of air carries the cloud and incipient rain drops upwards, but presently, in consequence of the increased capacity of the mass from the presence of a large quantity of water, the refrigeration of the air, in consequence of its diliatation, will be so far diminished as to prevent the condensation of fresh vapour, and ultimately to redissolve the upper portion of the cloud. This phenomenon, which has been noticed by Rankine in the cylinder of the steam engine, will account for the defined outline of the upper edges of cumulus clouds. The upward current no doubt extends occasionally to regions below the freezing temperature. If cloud be carried with it, snow or hail will be formed, which, if sufficiently abundant, will pass through the cloud and fall to the ground before it is melted. Now, the dry cold air in which the hail are formed is a perfect insulator. Ice has also been proved, by Achard, of Berlin, to be a non-conductor and an electric. Even water, in friction against an inuslator, is known from the rxperiments of Armstrong, explained by himself and Faraday, to be able to produce powerful electric effects, and this fact has been suggested by Farady to explain powerful electric effects in the atmosphere. Sturgeon has noted the remarkable developement of electricity by hail showers. Few heavy thunderstorms occur without the fall of hail. Hail, whether in summer or winter, is almost always, if not invariably, accompanied with lightning. In the presence of these facts, it seems not unreasonable to consider the formation of hail as essential to great electrical storms; although, as has been pointed out by Professor Thomson, very considerable electrical effects might be expected from the negatively charged air on the surface of the earth being drawn up into columns, and although, as the same philosopher has observed, every shower of rain gives the phenomena of a thunderstorm in miniature. The physical action of insulators and electrics in mutual friction must certainly produce very marked effects on the grand scale of nature. If we suppose that the falling hail is electrified by the air it meets, the electrification of the cloud into which the hail falls might thus be constantly increased until the balance between it and the inductively electrified earth is restored by a flash of lightning. If the hail is negatively electrified by the dry air with which it comes in contact, the latter will float off charged with positive electricity, which may account for the normal positive condition of the atmosphere in serene weather, as well as the electrification of the upper strata evidenced by the aurora borealis. The friction of wind has been supposed by Herschel to contribute to the intense electrification of the cloud which overhangs volcanoes during eruption.

*Kirchhoff on the Solar Spectrum, &c. Translated by H. E. Roscoe,

INSTITUTION OF CIVIL ENGINEERS.

The council of the Institution of Civil Engineers have awarded the following premiums for papers during the session 1861-62 :—

1. A Telford Medal, the Manby Premium, in books, and a Stephenson Prize of twenty-five guineas, to Charles Augustus Hartley, M. Inst. C.E., for his "Description of the Delta, and of the works recently executed at the Sulina Mouth, of the Danube."

2. A Telford Medal, and a Miller Prize of fifteen guineas, to John Henry Muller (of the Hague), for his paper "On Reclaiming Land from Seas and Estuaries."

3. A Telford Medal, and a Miller Prize of fifteen guineas, to John Paton, M. Inst. C.E., for his paper "On the Sea Dykes of Schleswig and Holstein, and on Reclaiming Land from the Sea."

4. A Telford Medal, to James Abernethy, M. Inst. C.E., for his "Description and Illustrations of the Works at the Ports of Swansea, Silloth, and Blyth."

5. A Telford Medal, to John Bailey Denton, M. Inst. C.E., for his paper "On the Discharge from Underdrainage, and its effect on the Arterial Channels and Outfalls of the Country."

6. A Watt Medal, to Joseph D'Aguilar Samuda, M. Inst. C.E., for his paper "On the form and Materials for Iron-Plated Ships, and the points requiring attention in their construction."

7. A Council Premium of Books, to James Brunlees, M. Inst. C.E., for his paper on "Railway Accidents—their causes and means of prevention."

8. A Council Premium of Books, to Captain Douglas Galton, R.E., F.R.S., Assoc. Inst. C.E., for his paper on "Railway Accidents, showing the bearing which existing legislation has upon them."

9. A Council Premium of Books, to Henry Charles Forde, M. Inst. C.E., for his paper on "The Malta and Alexandria Submarine Cable."

10. A Council Premium of Books, to Charles William Simens, F.R.S., M. Inst. C.E., for his paper "On the electrical tests employed during the construction of the Malta and Alexandria Telegraph, and on insulating and protecting Submarine Cables."

11. A Council Premium of Books, to James Atkinson Longridge, M. Inst. C,E., for his paper on "The Hooghly and the Mutla."

12. A Council premium of Books, to James Oldham, M. Inst. C.E., for his paper "On Reclaiming Lands from Seas and Estuaries."

THE NEW BRIDGES AT BLACKFRIARS.

After delays, councils, debates, and postponements almost innumerable, definite action is at last being taken in the matter of the new bridges at Blackfriars. The time that has been wasted by the City authorities in quarrelling over the various schemes submitted to their consideration has been long enough to have almost finished both the structures in dispute. It is more than a year since Mr. Page's designs were accepted, and about four months since the Common Council overruled the Bridge-house Committee, and rejected them. This time it is Mr. Cubitt's design which has been chosen, and we are assured that this decision is final, and that vacillation and delays are at an end. We hope this is so, not only as regards the decision itself, but as regards immediate steps to carry it into execution. What the public wants is a convenient, strong, and handsome bridge, and if they get this they won't much care to inquire whether Mr. Page or Mr. Cubitt builds it. Much of the delay, it is said, has been caused by the fact that alongside the new City bridge at Blackfriars the railway bridge of the London, Chatham, and Dover Company was also to be erocted.

As both these structures are important public works, and as new Blackfriars-bridge especially is one on the quick completion of which great interest is felt, a short outline of its chief features will be acceptable. This bridge, to be built by Mr. Cubitt, is to be five-arched, of mixed stone and wrought-iron, and, while its gradient on either side will be reduced to a slope less than half that of the present structure, the headway or space between high-water mark and the crowns of the arches will be quite as great, the increased strength of the wrought-iron ribs not necessitating their being of such a depth. The site of the new bridge will be exactly that which the old one now occupies, allowing, of course, for the difference of increased space which the larger dimensions of the new one will require. Its length is to be 963ft., and its width for traffic 75ft. This latter space is to be divided into one roadway 45ft. wide (wider than the entire width of the present bridge) and two footways of 15ft. each. Of the five arches the centre is to have a span of 189ft., the two arches on either side of this a span of 176ft., and the shore arches at either end a span of 167ft. each. The clear headway between high-water mark and the crown of the centre arch will be 27ft., the springing of the arches commencing about 18ft. above the water. The whole structure will be about 5ft. lower than the present bridge. The piers are to be of solid masonry, taken down into the London clay no less than 40ft. below high-water mark. These, by means of iron caissons, can be built without resorting to the cumbrous and expensive system of cofferdams. The caissons will be sunk on the exact spot to be occupied by the masonry of the pier, and forced down by pressure into the bed of the river. The water will then be pumped out, and the mud and gravel at the bottom dredged away, and as the dredging progresses the caisson will be forced deeper and deeper till the ultimate site of the foundations on the London clay is deeply penetrated. Here the masonry will be laid in immense blocks of granite, which will be bolted together and continued to the point above high-water mark where the springing of the arches commences. The arches are to be formed of ribs of wrought-iron, light in appearance, but, of course, of immense strength. Each arch will be composed of 10 of these ribs, each rib being placed at intervals of about 6½ft. apart. They are to be connected together by cross girders and covered in above with an iron floor. On this floor will be placed a thick layer of asphalte. and over all the light granite roadway pavement known as "stone pitching." The spandrils of the outer iron ribs on the east and west sides will be filled in with wrought-iron scroll work, and the whole surmounted with a handsome iron cornice and balustrade. Above the five stone piers we have spoken of red granite columns will be placed, so as to screen the junction of the wrought-iron ribs behind them. These granite columns, which are to be highly polished, will be nearly 7ft. in diameter and 18ft. high, with handsome pediments and capitals, the latter surmounted with richly-carved recesses in white stone. The cost of the bridge, including the temporary wooden bridge for the traffic while the new one is building, is to be £263,000, and the whole is to be completed in from two and a half to three years from the present date.

The railway bridge is hereafter to form, with that at Charing-cross and that at Chelsea, the great main avenues of communication between the lines north and south of the Thames. The size and position of its piers will exactly correspond with those for the City bridge, and (as the end of the cutwaters will only be 25ft. distant) it is proposed to connect the two together by a slight line of masonry or iron casing. Some such measure will, we think, be necessary to prevent the dangerous eddy currents which are otherwise certain to arise between the pier-heads. This railway bridge, of course, is taken at an uniform level across the Thames, leaving a clear straight headway between the openings (which, like the piers, correspond in width with those of the City bridge) of more than 29ft. from high water, making it on the whole 2ft. higher than the highest part of new Blackfriars. On each pier will be placed three groups of cast-iron columns—one in the centre and one at each end; each group consisting of four columns braced together, and each column 5ft. in diameter and 18ft. high. These columns will be tinted bronze colour, with highly decorative castings on pediment and capital, and their general effect from the river as to size and massiveness will more resemble the gigantic columns of Egyptian temples than any modern work we have yet seen. Resting on these groups of columns will be very powerful flat wrought-iron lattice girders. the outermost ones on the east and west sides, like the outermost ribs of the bridge, being filled in with ornamental brackets and scroll iron-work. This bridge is to be laid for four lines of rails, to run into the new station on the site of the old Fleet Prison, whence, by the Subterranean Railway, the communication will be direct with the King's-cross and Great Western lines.

As we have said, the works of this bridge have already commenced, and their progress is likely to hasten considerably the construction of the temporary wooden bridge that is to be erected when Blackfriars falls into such a state of dilapidation as to be unable to support its own weight. The piers of the railway bridge will come close to some of the most defective of those which by dint of timbering and stone ballast are enabled to support the arches. But the foundations for the railway viaduct are to be taken into the London clay, and the rotten basement of old Blackfriars will never bear this disturbance. Before the railway piers have been commenced a month, it seems very likely that Blackfriars must be closed against all traffic. This contingency, however, has been foreseen, and Mr. Cubitt is instructed to make a temporary wooden bridge for the foot and carriage traffic the instant the old one becomes dangerous, or that he commences his works for the new. This temporary one will be commenced on the east side of the present bridge, and midway between that and the intended railway viaduct. Its width for carriages will be the same as the present bridge roadway, but the footpath will be little more than half. It is to have five openings for water traffic of 70ft. span, and one at each shore end of 30ft. Of course the roadway over these openings will be carried on iron girders. By lowering the present approaches, the height of the temporary roadway can be brought 8ft. lower than that of the present bridge, and raised on beams above this temporary roadway the footway will be carried 9ft. higher. Not more than two or three months is required to complete the temporary bridge, which, though very strong, is simple in its method of construction. As far as the public are concerned this makeshift thoroughfare cannot be commenced too soon. There has been delay enough in coming to a decision as to whether a new bridge was wanted at all, but now that it has been shown to be imperatively necessary the least that may be expected is to begin the work as soon as possible. The designs have been accepted, the working drawings are nearly all complete, and if the Common Council do not again change their minds and revoke this decision, we hope soon to report that the works so long needed have actually been commenced.—*Times.*

REVIEWS AND NOTICES OF NEW BOOKS.

Results of an Experimental Inquiry into the Comparative Tensile Strength and other Properties of various kinds of Wrought Iron and Steel. By DAVID KIRKALDY. London: Hamilton and Co., Simpkin, Marshall, and Co. Glasgow; Maurice, Ogle, and Co. 1862.

Mr. Kirkaldy here presents us with a vast amount of information—arranged and classified in a very convenient manner for reference,—being the result of the most carefully-conducted experiments made for, and in the works of Messrs. R. Napier and Sons, Glasgow, under the sole management and responsibility of Mr. Kirkaldy. The testing experiments commenced on the 13th of April, 1858, and terminated on the 18th September, 1861.

Most of our readers are already, doubtless, aware of the opinion which we expressed as to the value of these experiments *(vide* ARTIZAN, January 1st, 1860); for having had occasion to be in Glasgow in December, 1859 (and witnessing the experiments then being conducted), we had an opportunity of becoming thoroughly acquainted with their value; and in our issue of January, 1860, we gave the results of some of these experiments (which had been communicated by Messrs. Napier, to the Institution of Engineers in Scotland, and are published in the vol. of their transactions for 1859) at length, and accompanied with the illustrations, forming the first four of the series of plates in Mr. Kirkaldy's work, now before us.

Since then, Mr. Kirkaldy, at the wish of the Scottish Shipbuilders' Association, drew up, with the concurrence of Messrs. Napier, a paper, which was read before the Association at its meeting in April last year, giving an account of the continued experiments, and the conclusions at which he arrived. Since the reading of this paper, Mr. Kirkaldy has issued the Essay now before us; and a careful perusal of which we commend to all practical men engaged in the useful employment of steel and iron, and to the scientific world in general.

A Practical Treatise on the Preparation, Combination, and Application of Calcareous and Hydraulic Limes and Cements. By JAMES G. AUSTIN, Architect. London: Trubner and Co. 1862.

A very useful work upon the subjects which it treats; and although the author has very modestly prefaced this work, by stating that he makes no great claim as to originality, he has succeeded in effecting that which he has more especially aimed at, viz.:—To attract public attention to the essential properties, analysis, combination, and application of limes and cements, as described in a work (long since out of print), by Dr. Brindly Higgins.

Mr. Austin having, during a long professional career, had ample opportunities of confirming the theories and experiments enunciated in Dr. Higgins' work.

Mr. Austin has interspersed throughout the present work numerous practical remarks. We recommend the work as being especially useful to the engineer, architect, and builder.

The following treatises and manuals have been received by us too late for a detailed notice in the present number of THE ARTIZAN:—

The Resources of Turkey, considered with especial reference to the Profitable Investment of Capital in the Ottoman Empire. By J. Lewis Farley. London: Longman, Green, Longman, and Roberts, 1862.

A Treatise on Ventilation, Natural and Artificial. By Robert Ritchie, C.E. London: Lockwood and Co., 1862.

Formulæ, Rules, and Examples, for Candidates for the Military, Naval, and Civil Service Examinations: also for Mathematical Students, and Engineers. By T. Baker, C.E., Division I.

Iron Work, Practical Formulæ, and general rules for finding the strain and breaking weight of Wrought Iron Bridges, with useful tables. By Charles Hutton Dowling, C.E., Division II. London: John Weale, 1862.

A Treatise on Military Drawing and Surveying, with a course of progressive plates. By Capt. W. Paterson. Professor of Military Drawing at the Royal Military College, Sandhurst. London: Trubner and Co., Paternoster-row, 1862.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

PASSING REMARKS ON THE FALSE AND ON THE TRUE PHILOSOPHY OF STEAM, AS A MOTOR APPLIED TO THE STEAM ENGINE.

To the Editor of THE ARTIZAN.

The title of the theme is intended to exclude all mere mechanical appliances, as not necessary to elucidate the subject; and moreover, the reader is necessarily supposed to be well acquainted with them, to enable him to form a correct judgment.

The fallacies by which many supposed new inventions have been from time to time supported, are incredible to all but the initiated in the mysteries of patents and inventions in this and other lands.

At present, however, it is intended to point out a few of the prominent errors, of the present day, in the application of steam as a motor, and how, by a fundamental difference in the mode of its application, in regard to recuperative supply and regenerative power, the utmost possible effective work done is obtainable with the least possible amount of fuel, and with the least damage to boiler and condenser.

But few greater absurdities are recorded, not having even the plea of novelty to recommend them, than some experiments of wide-spread renown, which were intended to prove the advantages of using steam mixture (a very proper name, as suggestive of quack), meaning thereby ordinary steam mixed with superheated steam, which operation was performed before the steam entered the cylinder of the steam engine.

A few years previous to the promulgation of this fallacy, there was another, which obtained considerable notoriety in relation to superheated steam, and which was supposed to be something else, a sort of condensible gas—that is to say, a gas not permanently elastic under low pressures, as all other gases are, and hence the supposed discoverer gave it the absurdly pedantic name of "Stame." Further, the utmost charity will say nothing; but those who are desirous of investigating the hallucination of the late Mr. James Frost, on that subject, will find them in the *London Mechanics' Magazine,* commencing with March, 1850.

The late Dr. Haycraft had made a similar mistake with regard to the economy of using superheated steam some twenty years before, but he had become convinced of his error, and, like an honest man, confessed it. And so did another one confess his error, in believing that he had discovered a great economy in using air blown into the boiler of a steam engine, as he supposed; whereas none had ever been blown in it at all, for the very sufficient reason that the bellows were burst, and the advantages proved to have occurred were due to philosophical firing alone. And yet, a hundred years after this fact, and forty years after its record by Farey, in relation to an eminent engineer, Fitzgerald, we have a repetition of this in the "Cloud Engines" of America, with the certificate of a very high authority as to economical working.

There is another fallacy in regard to superheated steam, which should not have required any experiment whatever to prove it; and that is, the superheating of steam in the smoke connection from a steam boiler. Here again we have the old engineering sin of producing an evil in order to apply a remedy. A good boiler cannot by any possibility allow of any abstraction of its heat from the smoke connection, without injury to the draught, and producing the consequent imperfection of fuel combustion; and, moreover, such a boiler must have, as an essential element, enough surface to abstract all the available heat.

So, then, the blower is called into requisition in sheer desperation, and more fuel is burned, as a matter of course. But, as more heat is generated than the boiler surfaces can absorb, a good boiler may thus be converted into a very bad one, notwithstanding some of the waste heat may be utilised by placing a heater in the smoke connection.

But here, again, to use a homely adage, we have got out of the frying-pan into the fire. We undertake to do, through the medium of a blower, and at a great cost of power, that which nature is quite able and willing to do for nothing, if not injudiciously interfered with. Nor is this all, for this "Boiler-maker's delight," the blower, is a most destructive agent to boilers.

We have next to arraign the steam-jacket; for although it has been exploded everywhere (and in the United States, only one steamboat is believed to have a steam-jacketed cylinder), it is now brought forward, if not as a new invention, certainly with a contempt for the opinions of those who have discovered its fallacy by practical experience.

But, say the *quid nuncs,* we must have steam of a higher pressure, and worked with more expansion than heretofore has been usual. The inevitable consequence of this arrangement is to increase enormously condensation in the cylinder by increase of temperature in the steam, and of surface in the cylinder, both internally and externally, whereby radiation is increased also.

The remedy, like all the previous ones, is a mere subterfuge to get over an evil which should be regarded as an engineering blunder. It is well-known that the steam-jacket can be made to show up very plausibly, if engineers are allowed to play "fantastic tricks." Some experiments recently made in America show this; but, although they were very imperfect, the reasoning founded upon them was still more so, for no other conclusion can be drawn from them than one entirely adverse to the economy of the steam jacket.

Although the steam jacket does, to some extent, prevent condensation in the cylinder, it is exposed at a higher temperature, and over a greater surface than the cylinder itself would be without it, and, therefore, the condensation must be greater, although it may be less disadvantageous than if it occurred within the cylinder itself.

Finally, the air-pump, the great offender, must be exorcised before any improvement is possible in surface-condensing engines. There are, it is true, so-called high-pressure condensing engines, but it is all a fallacy, for the thing is not possible; under the circumstances of a steamboat, which must use salt water for the boiler supply, at least the danger is too great, on account of scaling, to permit of its being so supplied. Nothing but pure water in the boiler, and a recuperative supply thereof, is admissable.

Leaving the air-pump for the present, let us return to the experiments (?) with the "mixture" of superheated and normal steam before referred to, for they are worthy, from their very unworthiness, of more than a cursory review. However incredible it may appear, these experiments were most imprudently brought forward and referred to as of authority, and no doubt had some effect in inducing the Admiralty to give up a steam ship to show them off again. They are narrated in the *Journal of the Franklin Institute* for April, 1854, by B. F. Isherwood, Esq., at that time a subordinate, but now Engineer-in-Chief of the U.S. Navy. In justice to this gentleman, it must be stated that he distinctly disavows all responsibility in the matter, and that he had nothing to do with them further than to record them. It does not, in fact, appear who is responsible for the experiments, excepting those who afterwards made use of them for a purpose. The question then is, was the user of these experiments under a delusion? It is difficult to say how far a bantling may delude its own father.

The first experiment (?) was made with a common non-condensing engine (commonly called high-pressure). The pressure of the steam in the boiler was 5·8lbs. per square inch above the atmosphere, and that in the steam chest 3·3lbs. (as inferred from the temperature, which alone is given). Of course it would not do to give an indicator card—it would look so foolish—for it would show a developement of less than three-quarters of an indicated horse-power, from a cylinder of 12·5in. diameter, with a 12in. stroke, and the piston making 29·84 double ones per minute. The area of the piston was, therefore, 122·718in., and its velocity 59·68ft. per minute. Hence we have :—

$$\cdot 73 = \left(\frac{3\cdot 3,\ 122\cdot 718,\ 59\cdot 68}{33{,}000} \right) \text{ I.H.P.}$$

This is actually less than one per cent. of the power obtainable from such an engine.

The next shuffle of the experimental cards is of the same character, and could have no other object in view than the wasting of as much fuel as possible.

The steam tug, *Jos. Johnson* by name, was used on this trying occasion, and we are coolly told that "the steam in the valve chest of the cylinder, in degrees Fahr. 195° pressure was therefore actually 2·2lb. per sq. in. belowthat of the atmosphere, and even that followed but five-eighths of the stroke; and this, we are told, was the ordinary condition of practice."

It is useless to proceed with such jugglery as this any further, for no one can be expected to take any more of the "mixture" in its present raw state.

Having elaborated eight fallacies, which do not admit of adjustment on any harmonic scale, it may not be without use to place them in something nearer chronological order than they have appeared.

The three first date about 80 or 90 years back; the fourth some 30 years, while the rest are all believed to be modern innovations of no account, except at the banker's, which they have depleted.

1. The air-pump condenser.
2. The steam jacket.
3. Air injected into the motor.
4. Steam, superheated, apart from the boiler.
5. "Stame" dangerously, " "
6. The "mixture," " "
7. The heater placed in the smoke connection.
8. The blower, to produce unnatural and dangerous draught.

Enough of the "false philosophy of steam," and now for the "true."

In stating the latter, it may be convenient to contrast it occasionally with the former, not very methodically, perhaps, but with sufficiently reasonable precision, considering the somewhat intricate nature of the subject.

"Steam Engineering in 1859" was the heading of several excellent articles which appeared in the May and June numbers of THE ARTIZAN of the year 1859. They were rather boastful articles, nevertheless, considering the latitude from which they emanated. Alas! those anticipations have not been, nor can they be, realised.

Instead of eradicating old fallacies which are fast becoming as chronic as the air-pump itself, modern physicists appear to be engaged in adding new ones to the already formidable list.

"The ultimate range of duty depends on the range of heat-fall, from boiler to condenser"—Coneybeare.* But "by lowering the temperature of the condenser, the boiler can only be fed by water, which is but little heated.—Regnault.†

Whatever of mere abstract truth may be discoverable in the first quotation, it is practically as great a fallacy as any of the eight previously enumerated, for I do suppose that the second quotation will be received as that of an undeniable fact.

"By lowering the temperature of the condenser" we produce nearly all the evils, which the complicated subterfuges of the day have been intended to cure. But the air-pump alone is responsible for all this, and the question therefore arises, how high shall the temperature of the condenser be? Clearly, it must be sufficiently high to eliminate the air-pump out of existence. Less than this leaves us with nothing but an arbitrary dictum of matter of opinion.

But there are other practical considerations which are quite as important as the one named, and, indeed, more so. High pressure is indispensable to the necessities of the times, but impossible to be applied with the air-pump, on account of the effect upon the boiler; and the safety of the boiler is of paramount consideration, and far beyond all others, and it can only be secured by admitting nothing but pure water into it. It has been proposed, by good authority, to purify the water, before it is put into the boiler, by some extra apparatus.‡ This reads very much like a joke in *Punch*, about the boy required for any light work, only to clean the glass of the Crystal Palace. Fancy the purifying of the boiler water for the *Great Eastern*. And yet that is precisely the only thing to be done, and nothing short of it will answer the purpose of economizing fuel and boiler, and ensuring safety.

And all this, and more too, is done, and has been in operation for nearly five years, with unvarying success, and in the most simple manner imaginable.

The water is pumped into the boiler perfectly pure, and at near the boiling point, by means the most simple and natural. It is now fully acknowledged, that the pumping of the water into the boiler, at a high temperature, is a source of great economy of fuel. It appears to arise from the fact that combustion is more perfect under hot than it is under cold water, which is the same thing as saying that more total heat is obtained from the same amount of fuel. Again, Leslie has shown that hot water absorbs heat more rapidly than cold water does; and there is no doubt that the metals obey the same law, and allow the heat to pass the more rapidly, the higher their temperature.

These remarks are supposed to elucidate some anomalies in the known economy of using high pressure steam which have not heretofore been accounted for, and, moreover, render it clear that it is not the fire, but the water, which wears and eventually destroys boilers, for otherwise they would last as long with bad as with good water.

To accomplish all the benefits derivable from the proposed true philosophy of steam, we have to raise the temperature of the condenser until the air-pump is eliminated out of existence.

This object will be attained by increasing the temperature something more than 100° F., which will bring the pressure in the condenser up to more than that of the atmosphere, and, of course, render the air-pump impossible of application.

The object in view, however, must not be supposed to be simply to get rid of the air-pump, for that is merely a necessity of the case of recuperative supply of pure water, to make up for the waste from the boiler. It must be understood, therefore, that the exhaust steam must be hot enough to boil the condensing water before it can leave the hot-well, and that the pressure of the steam upon its surface is sufficient to carry over this steam into a still condenser, to form the recuperative supply before mentioned.

Of course there will always be a back pressure upon the piston, as is the case with all high pressure steam engines, although not usually to so great an extent. Undoubtedly this is a disadvantage, but it is an unavoidable one, and of the slightest possible importance when compared with the advantages which the system affords, and to which it does not appear that any other can approach in safety and economy.

A few examples of imaginary but of no uncertain workings, may tend to elucidate the subject more clearly, giving under the two systems (the one in use and the proposed new one) the temperatures and pressures of the working steam as well as those of the condensers. Preliminary to the examples proposed being given, it cannot be too often repeated, in the words of Regnault (and from the force of which there is no appeal), that, by lowering the temperature of the condenser, the boiler can only be fed by water which is but little heated. Of course, the temperature of the condenser limits that of the feed-water on any system. And if, on the proposed new system, it can be shown that the temperature of the inside surface of a close condenser is sufficiently high to boil the condensing water on the outside of it, but within a close cistern or secondary boiler, with no more expenditure of fuel than is required on the old system without such appliances, then it is clear that a recuperative supply is obtainable from this source (cistern or secondary boiler), and at no cost whatever.

I shall not attempt to prove more than this; and, to avoid any hair-splitting calculations, shall consider a double, treble, or quadruple pressure of steam as costing in fuel in the same proportions.

The immense advantages of this recuperative supply of distilled water are of such paramount importance in economising fuel, prolonging the life of the boiler, and ensuring safety, as to completely dwarf all other considerations whatever.

Example No. 1.	With Air-pump.		New System.	
	F.°	lbs.	F.°	lbs.
Temperatures and pressures in cylinders	270°	42	378°	180
Temperatures and pressures in condensers ...	122°	2	230°	20
Differences	148°	40	148°	160

F.° means degrees Fahr. E lbs. Pressure per square inch.

Here we have fair working pressures of steam in cylinders and condensers under both systems, and what is the result? The cost of a cylinder full of steam at 180lbs. pressure is (on the liberal scale agreed upon) 4·3 times that at 42lbs. per square inch of pressure, while the effective working power of the unbalanced steam is 4 times. (To state, however, once for all, this excess of cost is not correct, although quite insignificant, and the real cost is but 3·82 times.)

The heat-fall is the same in both cases, viz., 148° F., and, therefore, the condensation in the cylinder will be in proportion to the internal surfaces exposed to its action. Allowing for the higher temperature of the cylinder externally, causing a greater amount of radiation, the condensation in the cylinder can scarcely exceed one-half the amount of loss, on the new system, which must be incurred on the old one.

The following examples require no special remarks, as the foregoing ones are equally applicable to them, without any material exception, on account of the reduced temperatures and pressures, which occasion a somewhat increased proportional fuel cost:—

Example No. 2.	With Air-pump.		New System.	
	F.°	lbs.	F.°	lbs.
Temperatures and pressures in cylinders	248°	28·8	356°	145·8
Temperatures and pressures in condensers ...	122°	1·8	230°	20·8
Differences	126°	27·	126°	125·

* *Civil Engineers' and Architects' Journal*, 1858, p. 302.

† *Journal of the Franklin Institute*, vol. 26 (3s.) p. 28.

‡ The *Engineer*.

Example No. 3.	With Air-pump.		New System.	
	F.°	lbs.	F.°	lbs.
Temperatures and pressures in cylinders	248°	28·8	278°	47·8
Temperatures and pressures in condensers ...	122°	1·8	230°	20·8
Differences	126°	27·	48°	27·

Example No. 4.	With Air-pump.		New System.	
	F.°	lbs.	F.°	lbs.
Temperatures and pressures in cylinders	248°	28·8	338°	115·2
Temperatures and pressures in condensers ...	122°	1·8	230°	20·8
Differences	126°	27·	108°	94·4

In the second of the three last examples it will be observed that the pressure of the unbalanced steam is the same in both cases, which is most decidedly disadvantageous to the new system. Nevertheless, what do we see? Suppose the fuel cost to be in proportion to the pressures, or as 47·8 to 28·8, the heat-fall, and consequently the condensation in the cylinder, is as 48 to 126; so that whatever is lost in fuel cost is at least compensated for by reduced condensation of the working steam, &c.

Suppose, in this worst possible conceivable case, the steam cost to be two-thirds greater on the new system than on the old, what then? the condensation in the cylinder will be but as 1 to 2·625 = (126 ÷ 48) or about 15 per cent., against 40 per cent. by the air-pump condenser, still leaving an apparent 25 per cent. against the new method. But, taking into account the value of the recuperative supply, even in this very extreme case the advantages are enormously in favour of the new method.

It has been contended for that the boiler being supplied with only pure hot water, and the steam formed therefrom being of a high temperature, the former absorbs heat more rapidly than if it were less pure or colder, and that the metal of the boiler, obeying the same law, allows it to pass more freely. It appears inevitable that the converse of this must also be true; and, therefore, the higher the temperature of the condenser the more rapidly will condensation be produced therein, with the same difference of temperature between it and the condensing water.

On the old system (with air-pump and surface condenser) taking example No. 1 for an instance, we find that the average combined temperatures of the cylinder and condenser

$$= 196° = \left(\frac{270 + 122}{2}\right)$$

while that of the condensing water may be taken at

$$70° = \left(\frac{60 + 80}{2}\right)$$

(entering at 60° and leaving at 80° F.), which gives a difference of 126° = (196 − 70) between the temperature of the steam to be condensed and the condensing water. On the new system, however, the difference in its favour is no less than 39° more, or

$$165° = (304 - 139) - 304° = \left(\frac{378 + 230}{2}\right)$$

combined average temperatures of the cylinder and condenser, and

$$139° = \left(\frac{60 + 218}{2}\right)$$

that of the condensing water, which is supposed to enter at 60° and leave at 218° F.

It is, therefore, perfectly safe to say, taking all things into consideration, that the new system requires but half as much condensing surface as the old one. But even that amount is quite superfluous, because the quantity of water required in the steam is greatly reduced, and, on the whole, there is no doubt that one-third of the condensing surface required on the old system will be amply sufficient on the new one.

There are ample reasons for believing that the following synopsis can be fully borne out, from calculations made upon data furnished by the successful workings, for a period of nearly five years, of a boiler and surface-condenser, upon which a Board of United States' Navy Engineers reported to the Secretary in 1859, and which report may be found in Isherwood's *Engineering Precedents*, vol. ii., p. 85.

Synopsis.

	Combustible per hour per indicated horse power, in lbs.	2
	Steam	22
	Condensing water	176*
1′	Grate surface	1·6 ft.
72′	Boiler water-heating surface........................	6·
	Boiler steam surface	6·
12′	Condensing surface	2·

T. A. R.

* Air-pump surface condensing engines usually require twelve times this amount of condensing water. There is, for instance, the *Adriatic*, which uses 40lb. of steam per hour per indicated horse-power, and requires fifty-four times that amount, or 2160lbs. of condensing water.

NOTICES TO CORRESPONDENTS.

N.J.—The following are the particulars relating to the vessel and her performances:—The centre of displacement is ·76 abaft the centre of low-water line; centre of buoyancy 6·4 below low-water line; displacement per inch at low-water line, 13·1 tons; length on low-water line, 240 feet; displacement on trial at sea (fine weather), 1492 tons, with 595 tons deadweight on board; indicated horse-power on that trial, 714; speed, 11·33 knots; revolutions of engines per minute, 36; revolutions of screw per minute, 90; gross register, $966\frac{35}{100}$.

Regalp (Neath).—We have handed your note to Mr. F. Roberts, Hon. Sec. of the Society, and who will communicate with you through the post if you will favour us with you address.

C. J. M. E.—We have not been able to procure in time the particulars of the "Enterprise" for which you enquire. We shall, however, hope to give these, together with a reply to the other portions of your letter, in our next number.

M. A.—It is stipulated that the age must not exceed 28.—Full particulars will be furnished you upon application, *by letter*, to the Secretary of the Admiralty, Whitehall.

D. R.—We have received your communication, and thank you for your carefully detailed information. We believe you are correct as regards the boiler plates, but as to the "complication" question, that is, of course, *another affair*, and entirely a question of opinion.

A. S. P.—We should refer you to the machine exhibited in the Swedish Court of the Exhibition, by C. Gustafsson, class 7, sub. class B, No. 260.

B. B.—We reget you should not be able to find the explanation you seek, and are at a loss to account for your non-success. We find on reference the following, which is so completely to the point that we must think you have been consulting, in mistake, some other volume, not to have yourself seen the explanation, viz.

$$\frac{V^3 D^{\frac{2}{3}}}{I.H.P.} \times C$$

is expressed as follows:—Multiply the cube of the speed (V^3) by the cube root of the square of the displacement ($D^{\frac{2}{3}}$), and divide the product by the (I. H. P.), the co-efficient of dynamic performance. The Paper from which this is extracted is by Mr. Charles Atherton, late of H.M. Dockyard, Woolwich. The title of the Paper is "Freight as Affected by Dynamic Properties of Steamships," and we again commend the Paper to your attentive perusal.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

General Steam Navigation Company v. Mare.—This was an action tried in the Court of Exchequer, to recover damages for the non-fulfilment of a contract to build a paddle-wheel steamer, the *Dolphin*, within the time specified. It appeared that the defendant, who then carried on business at Blackwall, entered into a contract on the 26th April, 1855, to build a paddle-wheel steamer for the plaintiffs, to be delivered complete on the 13th September, the same year, and the deed provided for a penalty of £10 for every day the completion of the ship extended over the stipulated period. About this time the defendant's affairs became embarrassed, and the plaintiffs had to pay a large amount over the contract price in order to complete the steamer. The action was brought to recover that amount, and also the penalties for the non-fulfilment of the contract to deliver the ship by the 13th September, which was not finished until the 20th November. The defence was, that the defendant was relieved of liability by the proceedings in bankruptcy. The question at issue involving a point of law, a verdict was taken for the plaintiffs for £1700, the other side having leave to move the full court.

Hatch v. the London, Dover, and Chatham Railway Company.—This was an action to recover compensation for injuries sustained through the alleged negligence of the defendants' servants. The defendants pleaded not guilty. The plaintiff was sixty years of age. On Christmas-day last the plaintiff and his wife spent the day at Bromley, and whilst at the Shortland Station, on the return home, he fell down some steps 15ft. deep. He was picked up in a state of insensibility, and continued so till he arrived in town. On his arrival home a surgeon was sent for, and the plaintiff was much shaken and injured. The defendants denied their liability. They alleged that the plaintiff had passed through a gate which was marked private, and that in so doing he contributed to the accident. The jury returned a verdict for the defendants.

Telegraphic.—An action has been decided in the Sheriff's Court, Glasgow, which arose from the following circumstance. The plaintiff, or pursuer, on one of the Electric and International Telegraph Company's blank message schedules, wrote instructions to his London correspondent to buy for him in the market "Three thousand Turks," meaning Turkish or Ottoman scrip, representing stock of the value of £3000. The words were distinctly written; nevertheless the Telegraph Company, who were the defendants, forwarded the message to buy "Three thousand Trunks," and accordingly 3000 Trunks, that is, £3000 worth Consolidated Stock of the Grand Trunk Railway of Canada, were purchased. The pursuer alleged he sold his stock at a loss of £15. The Company maintained they were not liable for mistakes of this character unless the message was repeated, and the Court held that the pursuer could not recover.

MILLIKEN *v.* THE L. & N. W. RAILWAY COMPANY.—This case, recently tried in the Court of Exchequer, London, forcibly points out the necessity for a periodical and careful examination of boilers of railway engines and steamboats. It will be remembered that the boiler of an express train, on the London and North-Western Railway, burst in the month of July, last year, while running with the Irish mail train near Rugby. Amongst the passengers injured was the Rev. Mr. Milliken, a clergyman holding a living of about £300 a-year. By the shock which followed the explosion, his head came into collision with the side of the railway carriage. At first it was hoped he had not been materially injured, but on his proceeding to Dublin the injuries developed themselves, and eventually ended in paralysis. He sought compensation from the company in the Court of Exchequer, London, but for some reasons not clearly ascertainable the jury did not agree upon a verdict. It was elicited, however, by the evidence that the boiler was originally weak, and had been used incessantly. For nearly four years it had run at the rate of 38,000 miles in the year, without any attempt at internal examination. The engine had, in fact, performed seventeen 'years' work in ten years, and had been examined internally but once! The fragments proved that the barrel of the boiler had been furrowed by corrosion for a total length of nearly eight feet along the seams, and in some places the corrosion was so deep as to leave only the thickness of one-sixteenth of an inch. The hydraulic test cannot err, and discovers the most minute defects. The company urged, in their defence, that "such a test was never resorted to by any of the great companies." The matter becomes one of public interest when it is known that great companies may not examine their boilers internally for six years, and never use the hydraulic test. Many of the boilers on railways and steamships may be corroded to the thickness of one-sixteenth part of an inch, nor will the fact be ascertained until some disastrous explosion takes place. The law ought to provide that all steam boilers should be internally examined, if not by the hydraulic test, at least once every year. There is no excuse for neglecting this precaution. The examination costs but a trifle, and causes but short delay. As the law at present stands, a hundred lives may be wheeled along by a great company, with but a quarter of an inch of corroded iron between them and death.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any fact, connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts (for which we are chiefly indebted to the *Chemical News*), Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

NEW MANUFACTURE OF GUNPOWDER.—Mr. W. Bennetts, of Tuckingmill, has invented a new method of manufacturing gunpowder, the ingredients consisting of lime, nitre, sulphur, and charcoal; the lime is dissolved in a sufficient quantity of water to bring the other elements into a paste. The lime after having been made into a solution is strained through a fine sieve; this solution is then added to the other ingredients, and the whole is put into a mill and ground until it becomes a paste; it is then taken out of the mill and passed between two rollers, one grooved and the other plain. The paste by passing between the rollers is formed into long strips of a triangular shape; it is then carried on an endless web or canvas over some hot tubes, which are heated by steam, hot water, or any other artificial heat which may be applied; by this means the strips are easily broken into grains. This mode of manufacture prevents a great deal of danger, as the powder is pulverised and brought into grain while in a wet state. The lime makes a firm grain, resists the damp, and gives it a degree of lightness which increases the bulk 25 per cent. over ordinary gunpowder—a great advantage for blasting purposes. Plaster of Paris, blue lias, Roman or Portland cement, or other strong cementing substance, may be used as a substitute for lime. And the patentee finds that for blasting purposes the following proportions answer well—that is to say, nitre, 65lbs.; charcoal 18lbs.; sulphur, 10lbs.; and lime, 7lbs.; but the proportions may be varied according to the strength required.

IMPORTATION of coals into London by sea in the month of June, 904 ships, containing 271,194 tons. Importation of coals into London by sea from January 1 to June 30, 1,663,173 tons, being a decrease in the present year of 31,562 tons. Importation of coals into London by railways and canals in the month of June, 97,480 tons. Importation of coals into London by railways and canals, from January 1 to June 30, 672,583 tons, being a decrease in the present year of 176,524 tons.

HYDRAULIC PRESSES.—For many purposes for which presses are employed, such for example as for packing cotton and other fibres, and similar materials, the press is required during a considerable portion of its stroke to exert but a comparatively small pressure, whilst for the latter portion of the stroke a much heavier pressure is required. Mr. M. Scott, of Parliament street, proposes to employ a compound press, consisting of two or more concentric cylinders. The innermost is fitted with a ram like an ordinary hydraulic press, the cylinder is closed at the bottom, and is made itself to serve as the ram of another hydraulic press formed with the next concentric cylinder, and this may in turn form the ram of a third press. When the press is set to work the water from a force-pump or accumulator is directed first into the interior cylinder, and as this is of small diameter the ram thereof rapidly rises, but the pressure will be comparatively light. As soon as this pressure proves insufficient a cock placed on the supply-pipe of the inner cylinder is closed, and another cock is opened, so as to admit the water from the force-pump or accumulator to the second cylinder. In this manner the ram of the second press, which is the cylinder of the first, is raised, carrying its own ram with it, this being unable to descend, being blocked by the water enclosed beneath it. When the second cylinder is brought into work the action of the press will be slower, and the force exerted will be greater in proportion as the sectional area of the ram of the second press (or the cylinder of the first) exceeds the sectional area of the ram of the first press. Where a third cylinder is employed it is brought into action after the second in a similar manner, the second press being then in turn blocked by the water enclosed in it. The important feature in the invention is the blocking of one press, whilst a more powerful one is caused to act against it thus—Two separate hydraulic presses, the one of small and the other of large power, may be arranged one at each end of a frame, the material to be pressed between them is received between the two presses, and is partly compressed by the press of smaller power, then this is blocked by enclosing water in it, and the press of greater power is put in action to complete the compression. This arrangement may also be employed where mechanical blocking is used in place of or together with water blocking.

ELECTRIC CLOCK.—This is an invention by Mr. C. G. Gumpel, M.E. By this plan the oscillations of the pendulum are independent and free of any influence from the motive power (whether electricity or gravity). The pendulum is compensated. The rod, good white deal, is baked, and soaked in a mixture of beeswax, oil of turpentine and linseed oil, and then French polished to prevent absorbtion of moisture. The compensation consists of a zinc tube (sheet zinc) resting on the adjusting nut at the bottom of the wing rod; on the top of the zinc tube rests the cast iron bob by means of a plate screwed on the latter. The proportions are the following:—

Co-efficient of Expansion.

White deal	23
Cast iron	66
Zinc	170

Length in Inches.

Cast iron bob and also zinc tube	7·17
Wood rod	$39·14 + \frac{7·17}{2} = 42·72$

Expansion Upwards.

Of zinc tube	$7·17 \times 170 = 1218·90$

Expansion Downwards.

$$\left.\begin{array}{ll}\text{Of wood rod} & 23 \times 42·72 \\ \text{Of cast iron} & 66 \times \frac{7·17}{2}\end{array}\right\} = 1218·84.$$

The pendulum is suspended by means of an agate (with the groove inverted) on a cast steel edge (slightly rounded). By this arrangement the dust cannot accumulate to destroy the surface, while the rounded edge produces a rolling motion, preventing the sharp edge of the steel wearing into the stone. (The pendulum by itself oscillated 1¼ degrees at a quarter to eleven o'clock one evening, which had subsided, by about seven the following morning [after eight hours] to ¼ degree). The weight of the pendulum bob, with zinc tube, is about twenty-one pounds. The pendulum in this clock has nothing to do but to disengage he slight arms, from which it receives the required impulse. These arms descend only about one fiftieth part of an inch more than they are uplifted, and yet maintain an oscillation of the pendulum of 2½ degrees. The acting weight suspended from the curved lever, for the purpose of uplifting the impulse arms, is 2¾ drachms, exerting a pulling pressure (longitudinally) of about 1½ drachms at the point, where the arms hold the curved lever, so that the actual force required to disengage the arms is a high fraction of a drachm (the hooks of the curved lever and the pin in the mpulse arms being hardened and polished cast steel.) Hence the pendulum insures a correct time-keeper, equal (by even inferior workmanship) to the best astronomical clock. In the best known electric clock, the pendulum makes a contact at each oscillation by bending a spring, which, in itself, as the temperature varies, will influence the rate of the clock. Besides the manner in which the impulse is imparted to the pendulum in that clock is not free from friction, and tends to produce "wobbling," as the impulse, although parallel, is not in the same plane as that in which the pendulum oscillates. The contact makers are formed of iron cups, containing mercury, into which dip pieces of copper with iron ends. The one enters the mercury before the other leaves, so that no spark from the direct current can oxidize the surfaces of the contact makers, as both transmit the same current alternately; the left one to the magnet of the pendulum, the right one to the clock. In the clock a separate contact is made every minute, which will keep any number of filial clocks going, all showing the same (that is correct) time. The minute wheel shows (in the clock exhibited) a method of moving the hands of large clocks by means of two pins (placed diametrically) gearing into an ordinary wheel. It is impossible to shift the hand; and if held it will always, within the minute, place itself right. The clock is intended for large mansions, palaces, hotels, clubhouses, warehouses, hospitals, &c. The pendulum in an airtight case being fixed on the basement floor on a good foundation, while the battery is placed at any convenient spot easily accessible. The inventor claims the application of the same escapement to clocks moved by gravity, in which it is stated it will, undoubtedly, show its superiority over other escapements for the purpose for which a clock is intended—correct time keeping.

EXCAVATING MACHINERY.—An ingenious machine, designed to aid the workmen in the operation of working, winning, or mining coal, clay, shale, and other minerals, or earthy matters, has recently been patented by Mr. James Hemingway, of York; it consists, firstly, of a frame in which are mounted circular saws, or a revolving wheel or wheels, or disc or discs, to which are attached saws or other cutters, either toothed or edged, separately or combined, as may be found most useful, which wheels or wheels, disc or discs, saws or cutters are caused to revolve simultaneously, either by manual labour, or by steam or other power. This machine may be arranged so as to make horizontal, perpendicular, or oblique cuttings, and is to be used for the purpose of cutting any square or other formed block of coal or other matter, which it is desired to "win" or get, so as to partially detach the same from the general mass, and thus render its complete separation therefrom by the ordinary means much easier than heretofore. A modification of this apparatus consists of a frame carrying straight saws or cutters with toothed edges, which are driven by manual labour, or by steam or other power, so as to reciprocate backwards and forwards in a right line, and thus effect the desired cuttings by a reciprocating instead of a revolving movement, and is intended to be used in the same manner and for the same purposes as the apparatus previously described.

THE POWDER TRADE.—The consumption of powder in Cornwall for blasting purposes is very considerable; probably not less than 15 tons a week, or nearly 800 tons a year, and the result of any experiments in an article which enters so largely into the cost of mining operations cannot fail to be of great interest. The present cost of gunpowder to our mines is about £50 a ton; about £4 a ton less than it was two years since (chiefly brought about by the increased competition in the manufacture of the article), although in the meantime saltpetre, a very important and expensive ingredient, has advanced about £8 a ton—refined saltpetre now fetching £46 a ton, instead of £38 as formerly equal to £5 per ton on the cost of gunpowder.

THE QUANTITY OF COAL, cinders, and culm shipped coastwise in the United Kingdom, from port to port, in the year 1861, was 10,992,597 tons, an increase of 270,000 tons over the previous year. The quantity of coal brought into the port of London in the year was 5,232,082 tons, an increase of 159,000 tons over 1860. The proportion arriving by inland conveyance is constantly increasing; in 1858 it was 1,213,463 tons; in 1861, 1,665,080 tons. The export of coal, cinders, and culm in 1861 reached 7,855,115 tons, of the declared value of 3,604,790—a considerable increase (533,000 tons) over the export of 1860. France took 1,452,208 tons in 1861.

Australian Sovereigns.—The Commons' select committee, on the subject of legalising the circulation in the United Kingdom of sovereigns coined at the Sydney branch of the Royal Mint, report that this coinage is increasing, and was about £800,000 in the first quarter of the present year. These coins are of equal fineness and weight with the Tower-hill sovereigns, and the Master of the Mint is equally responsible for them; yet they have the privilege of circulation in certain colonies only. The only difference is that, the alloy being more of silver and less of copper, the Sydney sovereign is not considered so durable as the English; but there is no sufficient inducement to cause the systematic introduction of light Australian coin into our home circulation. The limited privilege of circulation is, of course, a disadvantage to the Australian coinage. The Committee proposed that an end be put to this distinction, and recommend that the existing Sydney gold coinage be withdrawn from circulation, and that gold coin be issued from the branch mint there, having as nearly as possible the same alloy as that of London, and having currency wherever gold coin minted in London is current; that it have a mint mark to distinguish it; that it be kept at such an amount as to prevent any undue inducement to the importation into the United Kingdom of gold in coin rather than in bars, and that the charge for the branch mint should be provided for by permanent appropriation by the Legislature of New South Wales rather than by an annual vote.

Petroleum.—A bill has been introduced in the House of Commons, and passed through committee, for the safe keeping of petroleum, and which is to include any product that gives off an inflammable vapour at a temperature of less than 100 degrees Fahrenheit. Vessels bringing it into port are to conform to any harbour regulations that may be made respecting it, under a penalty of £20; and not more than 25 gallons is to be kept within 100 yards of a dwelling-house or warehouse, except under special license from the municipal or other authorities of the place. Persons contravening this provision will render themselves liable to a penalty of £20 a-day. It is also to be provided that petroleum may be searched for in the same manner and under the same warrants as gunpowder.

Arc of Parallel from Valentia to the Volga.—The Russian portion of this great work is far advanced, and will, it is stated, be finished during the present summer. The geodetic junction between Britain and Belgium has been completed several months since by Sir Henry James. The Astronomer Royal has, therefore, made arrangements, with the co-operation of Sir Henry and the Magnetic Telegraph Company, for the early repetition of the measure of astronomical longitude between Greenwich and Valentia; and two assistants of the Royal Observatory, Mr. Dunkin and Mr. Criswick, will at once proceed to Valentia for the determination of local time and the management of galvanic signals. The Admiralty have furnished the funds for the contingent expenses, and some of the requisite instruments have been lent by the Astronomical Society, and by Mr. Simms.

Cotton in India.—The charge for conveying cotton by railway in India, according to a Parliamentary blue-book, is now from 1d. to 1½d. per ton per mile. The mode adopted of carrying it by bullocks and in country carts involved an expense of about 3d. to 3½d. per ton per mile, and the cotton is so much injured during its transit that the cost of conveyance really amounts to about 4½d. per ton. The railway charges of 1d. and 1½d. exhibit, therefore, a very favourable contrast, and will enable the merchant to reduce the price at Manchester to £4 or £4 10s. a ton, or nearly a halfpenny per pound for all cotton brought from a distance of 300 miles in the interior.

Public Income and Expenditure.—On the 26th ult. a parliamentary return was issued of the gross public income and expenditure of the United Kingdom for the year ended the 30th June. The total revenue was £69,685,788 13s.; the total ordinary expenditure was £70,407,867 13s. 1d., which is an excess over income of £722,079 0s. 1d.; but the sum of £1,120,000 was set apart for the expenses of fortifications, and this makes the excess of expenditure over income in the year £1,842,079 0s. 1d. The balances in the exchequer on the 30th of June amounted to £6,104,378 14s.; at the corresponding date in 1861 the balances were £5,838,831 19s. 5d.

Parliamentary Returns Relating to Corn, &c.—A return, just issued, shows that the quantities of corn and grain, flour and meal, imported into the United Kingdom in the year 1859, were 10,270,774 imperial quarters; in 1860, 14,494,976; in 1861, 16,094,914. The quantity of foreign and colonial corn, grain, meal and flour retained for home consumption was 10,143,355 imperial quarters in 1859; 14,484,300 in 1860, and 15,760,551 in 1861.

Public Works in Ireland.—The thirteenth annual report of the commissioners, lately published, shows that up to the 31st of March, 1862, 3713 loans had been sanctioned; but, as mentioned in previous reports, during the period which has elapsed between the year 1847, when the first loans were made, and the termination of the period reported on, considerable sums which had been so sanctioned have been cancelled by this board, under the powers given in the Act 13 and 14 Vict., c. 31. At the close of the financial year ending March, 1862, there remained unappropriated out of the fund of £2,000,000, voted by Parliament for the land improvement service in Ireland, the sum of £304,438. The sum issued on account of works up to the 31st of March, 1862, amounted to £1,625,981, of which £1,533,671 was expended on the loans which have been completed, and £92,310 has been issued on 288 loans, which are in progress, or have not been finally closed. These totals comprehend 251 loans, amounting to a sum of £87,410, which have been sanctioned, to proprietors for the erection of farm buildings, and 12 loans, amounting to £7150, for the erection of labourers' dwellings.

Muntz's Patent Metal.—The trials made with this metal for sheathing the bottom of ships having proved highly satisfactory, directions have been received at Chatham for it to be manufactured at that dockyard, and supplied to the various Government yards requiring it.

Atmospheric Tidal Laws.—M. Mathieu (de la Drône), who may be recollected in connection with the French republican assemblies of 1848, affirms that he has discovered regular tides in the atmosphere, precisely analogous to those of the sea, and which reduce varieties of temperature to settled rule, by which the weather can be foretold for days, weeks, and even months in advance, with scientific accuracy.

Belgian Iron Paint.—The Belgian "minium," or iron paint, made at Anderghem, is a pure iron oxide mixed with about 1-4th of its weight of silicious clay. It is said to contain no acid, and is now extensively used in this and other countries for painting ships' ironwork, gasholders, &c.

New Lifeboat for Portugal.—On the 23rd ult. some interesting and very satisfactory trials were made in the Regent's Canal Dock, Limehouse, with two lifeboats on the plan of the National Lifeboat Institution, built by the Messrs. Forrest for the Portuguese Government. The boats are respectively 32ft. long and 7ft. wide, and rowing six oars single banked. They were capsized by means of some tackling attached to an hydraulic crane. They self-righted instantly, and each boat discharged the water shipped in the operation in 25 seconds. When seventeen men were on board one of the boats, it was found that her gunwale was only just brought awash—thus showing her great stability, and the difficulty that would be experienced before she would capsize. With twelve men on board, it was found that the boat would still free herself of any seas she might ship. Messrs. Forrest are building four additional lifeboats for the Portuguese Government, and they have also on hand several boats belonging to the National Lifeboat Institution. The Tynemouth, Appledore, Blakeney, Howth, and Withernsea lifeboats, are nearly ready to be sent to their stations.

Electricity producing Musical Sounds.—A pool of mercury, from one to three inches diameter, is formed in a circular vessel of glass or gutta percha; this is surrounded by a ring of mercury about one-eighth to one-tenth of an inch wide, and both are covered to the depth of about half-an-inch with rather a strong solution of cyanide of potassium. The pool of mercury is then connected by a platinum wire with the positive pole of a powerful voltaic battery, and the ring of mercury is connected with the negative pole. A continuous harmonious sound is then produced.

Powerful Hydraulics.—In California a hydraulic is a high head of water conveyed through a pipe, and applied to wash down the face of gravelly hills and banks containing the auriferous deposits. Thus applied, water exerts a tremendous force in levelling hills and exhuming the golden nuggets. At Brandy City, in Northern Sierra, are rich and extensive diggings, which have been hard to work, on account of cement and hard gravel; but they now have several powerful hydraulics at work there, one of which has a fall of 240ft., through a 15-inch pipe. This is said to be the most powerful in the State, and will lift boulders of detachments of cement of a ton weight, when brought to bear beneath them.

Metropolitan Sewage.—On the 12th ult. a party, consisting of upwards of 200 noblemen, members of Parliament, the Metropolitan Board of Works, &c., visited Greenwich and inspected the southern outfall main drainage works, just completed by Messrs. Webster. The sewer was illuminated for a considerable distance, and refreshments were provided.

NAVAL ENGINEERING.

The "Meanee," 81, 400 H.P., attached to the Chatham steam reserve, is to be fitted for commission to take the place of the *Edinburgh*, 60, 600 H.P., guardship, at Leith. Orders have also been given for her to be supplied, in addition to her other armament, with two 110-pounders, and two 40-pounder Armstrong's.

The "Severn," 51, 500 H.P., belonging to the first-class steam reserve at Chatham, has left the Medway, and at Plymouth is to be immediately brought forward for commission, for service in the East Indies.

The "Arethusa," 51, 500 H.P., is to be fitted for the first division of the steam reserve in lieu of the *Severn*.

The "Prince Consort," 51.—The following are the chief dimensions of this armour-plated frigate, recently launched at Pembroke:—Length between perpendiculars, 273ft.; length of keel for tonnage, 232ft. 8¾in.; extreme breadth, 58ft. 5in.; breadth for tonnage, 57ft. 2in.; moulded breadth, 56ft. 4in.; and depth of hold, 19ft. 10in. This fine frigate is of 4045 tons burden, and will receive engines of 1000 horse power.

The "Argus," 6, revenue screw steamer, of 60 horse-power, has made her official trial of speed at the measured mile at Stokes Bay, on the conclusion of repair for recommission; she is fitted with a common screw, having a diameter of 8ft., a pitch of 8ft. 8in., and a length of 1ft. 6in. Her draught of water was 7ft. 9in. forward, and 10ft. 6in. aft. The mean result of her runs at the mile gave her a speed of 85·11 knots.

The Racoon, 22, 1467 tons, 400 horse-power, was taken out of Chatham Harbour on the 15th ult., to the Maplin Sands, for the purpose of testing the working of her engines, and ascertaining her rate of speed since the alteration of her machinery. During the trial, six runs were made at the measured mile, with full boiler power, giving an average of 10·75 knots per hour at full speed, half speed not being tried. The result of the trial was hardly as satisfactory as had been anticipated, the vessel, since the alterations and improvements made in the machinery, having been expected to attain a higher rate of speed. During the runs the number of revolutions made by the screw was 58, at full speed, with a pitch of 26, the screw being Smith's common propeller, not variable, with the leading corner removed. The draught of water forward was 16ft., and aft. 17ft. 2in.; vacuum, 26; and the temperature of the engine room, 68.

The "Zealous," 90, now well advanced in construction at Pembroke Dockyard, will, it is expected, be soon converted into an armour-plated man-of-war, upon Mr. E. J. Reed's principle. There are several smaller men-of-war in frame at the same dockyard, which will ultimately, it is anticipated, be armour-plated.

The New "Monitors."—These new vessels are larger and far more powerful than the *Monitor*, but the principle of their construction is the same. The turrets are 21ft. in diameter, and 11in. thick, which is 3in. thicker than the *Monitor's*. Each vessel is to be armed with two 15-in. guns, which is 4in. longer than those of the *Monitor*. Their speed will be 10 miles per hour.

The "Columbine," 4, screw steam sloop, 669 tons, which was recently launched at Deptford, and fitted at Woolwich with direct-acting horizontal engines of 150 nominal and 600 indicated horse-power, by the Greenock Foundry Company, was taken on trial at the measured mile, at the Mapling Sands, on the 24th ult. The results were most satisfactory. She attained an average speed of 10·643 knots per hour, with full boiler power, and 8 knots per hour with half boiler power. She made 103 revolutions; her pressure of steam, 20lbs.; vacuum, 25; her Griffiths' screw has a pitch of 13ft., and a diameter of 10ft.; her draught of water aft was 12ft. 7in., and forward, 9ft. 7in.

The "Shannon," screw frigate, sailed from Spithead on the 26th ult., on a cruise pending the casting of the blades for the experimental Griffiths' trial, for the purpose of fully testing the merits and demerits of the four-bladed *Mangin* (French screw), in the various positions and circumstances in which a ship would be placed under both steam and sail, separately and combined, during sea service. The screw has its four blades set in parallel pairs, and was tried by the *Shannon* on the second of her recent series of experimental trials on the 17th of May last, when it gave the ship a speed of 11·328 knots, with an indicated horse-power of engines of 2030·72. The mean pitch of the screw is 25ft., its diameter 18ft., and its length 3ft. The area of one blade is 19·5ft.; the four blades 78ft. The weight is 7 tons, 7 cwt., 3 qrs. From its peculiar form it requires but a narrow aperture as a "lifting" screw, for the screw well in the ship's stern. Its blades, however, from being set close together, lock the water between them in the screw's revolutions, and with a peculiar and violent beat in the water the working of the screw transmits an extraordinary amount of perpendicular motion to the ship's hull. So great was this movement during the trial, that the bell over the captain's cabin was more or less kept ringing. On the *Shannon's* return from her cruise with the *Mangin*, she will commence her trial with the Griffiths' with two, three, or four blades.

Armour Plating.—The Lords of the Admiralty have not exactly made up their minds as to the nature of the armour with which the sides of the *Agincourt, Minotaur, Northumberland*, and *Prince Albert* are to be protected. It was originally intended that the plates to be placed on those ships should be 5½in. thick, on a teak backing of 9in., but the experiments of Monday have induced their lordships to pause, and they have requested the different contractors to send in estimates of the cost for reverting, in the case of the above-named ships, to the old *Warrior* plan of 4½in. iron and 18in. of teak, if, on the consideration, it should be decided upon abandoning their first intentions.

The Danish Gunboats.—The Thames Ironworks and Ship-building Company of Blackwall, and Messrs. John Penn and Son, engineers, of Greenwich, have recently completed two very fine iron armour-plated gunboats for the Royal Danish navy. They are about 600 tons measurement, with engines of 100-horse power, and at the mile trial attained a speed of about 11½ knots.

Shot-Proof Ships.—From a recent return to Parliament, the number of proposals and plans for the purpose of shot-proof ships submitted to the Admiralty between the 1st of May, 1859, and the 1st of May, 1862, amounts to 590. The whole were, in the first instance, referred to the Comptroller of the Navy and the assistant officers of his department for consideration and report; 85 were subsequently referred to the committee on iron plates; 19 to Captain Hewlett, commanding the gunnery ship at Portsmouth; and 1 to a special committee.

Naval Appointments.—The following appointments have taken place since our last:—J. A. Kitt, First-class Assist. Engineer, to the *Sanspariel;* W. Williamson, confirmed as Second-class Assist. Engineer, and appointed to the *Euryalus;* W. E. Prescott, Acting Second-class Assist. Engineer, to the *Asia*, as supernumerary; W. Lowther, Chief Engineer, to the *Fisgard*, for the *Prometheus*; P. Butler, Engineer, to the *Cumberland*, for the *Columbine;* C. C. Hyde, promoted to First-class Assist. Engineer; J. G. Oakshott, Chief Engineer, to the *Hastings*; R. Holman, Chief Engineer, to the *Fisgard*, for the *Aledo;* J. Deal, Chief Engineer, to the *Resistance;* H. H. Mothersole, Engineer, to the *Cumberland*, for the *Mayflower*; N. Brodie, Engineer, to the *Resistance;* G. Batchelor, supernumerary, to the permanent list as Engineer; R. Mockett and F. Hight, First-class Assist. Engineers; V. C. Friend, Second-class Assist. Engineer, and J. R. Abbott and J. M'Millan, Acting Second-class Assist. Engineers, to the *Resistance;* T. B. Jordan and J. Rankin, Acting Second-class Assist. Engineers, as supernumeraries to the *Cumberland;* W. G. Page, Acting Second-class Assist. Engineer, to the *Asia*, as supernumerary; W. Williamson, Engineer, to the *Revenge*, for the *Syrian*; H. Cooper, Engineer, to the *Rattler;* J. H. Brettell, Engineer, to the *Fisgard*, as supernumerary; R. W. Hulford, promoted to Engineer; A. Young, First-class Assist. Engineer; C. Deal, Second-class Assist. Engineer; and H. Benbow, Acting Second-class Assist. Engineer, to the *Rattler;* F. J. Taplin, Engineer, to the *Cumberland*, for the *Argus;* J. Hill, confirmed as Engineer, in the *Fisgard;* W. Rumble, Acting First-class Assist. Engineer, to the *Cumberland*, for the *Sepoy;* W. Cowap, Acting Second-class Assist. Engineer, to the *Defence;* W. H. Rundle, Chief Engineer, to the *Indus*, for the *Severn*, vice Weeks, placed on half-pay; J. Rankin, Acting Second-class Assist. Engineer, to the *Indus*, as supernumerary; G. F. Bardin, Chief Engineer; T. E. Woodfield, Acting Engineer; J. Steven and R. C. Oldknow, First-class Assist. Engineers; J. F. H. Hathersley and H. Aiken, Second-class Assist. Engineers; and P. Blanck, Acting Second-class Assist. Engineer, to the *Edgar;* C. Salmon, Acting Second-class Assist. Engineer, to the *St. George;* G. Batchelor, Engineer, to the *Vivid;* J. Lawson, Engineer, qualified for charge in the *Cumberland*, for the *Racoon;* W. Rumble, confirmed First-class Assist. Engineer; S. Clements, Chief Engineer, to the *Liffey;* J. Leatham, Engineer; J. Boscell and W. Tottenham, First-class Assist. Engineers; W. P. Ward and W. Dawe, Second-class Assist. Engineers; and J. Richardson, Acting Second-class Assist. Engineer, to the *Liffey;* W. Fenton (A.), First-class Assist. Engineer, to the *Revenge;* T. Parker, Engineer, to the *Cumberland*, for the *Jaseur;* W. Skeen, Engineer, to the *Asia*, for the *Ernest*, confirmed; P. Rosewarne, First-class Assist. Engineer, to the *Indus*, for the *Sparrow;* W. Rundle, Chief Engineer, and J. Bannerman, Engineer, to the *Severn;* R. Beazley, First-class Assist. Engineer, to the *Fisgard*, as Supernumerary; R. H. Jenkyn, First-class Assist. Engineer; E. C. Spencer, Acting First-class Assist. Engineer; D. Wilson and W. Goldie, Second-class Assist. Engineers, to the *Severn;* C. R. Lacy, First-class Assist. Engineer, to the *Indus;* W. Vawdry, J. Milne, W. Stretton, and W. T. Searle, Acting Second-class Assist. Engineers, to the *Cumberland*, as Supernumeraries.

The "Rattler," screw steam sloop, was taken from her moorings in Sheerness harbour for the trial of her machinery at the measured mile. Capcain T. P. Thompson, of the Steam Reserve, had charge of the vessel, and Mr. George Blaxland, chief engineer in the Sheerness-yard, Mr. Urquhart, engineer of her Majesty's ship *Collingwood*, and Mr. Martin, assistant-master shipwright, were in attendance on the part of the Government. The contractors were represented by Mr. Heabert Maudslay and Mr. Talfourd Field. The machinery, which was built by Messrs. Maudslay, Son, and Field, was in charge of Mr. Warrener, manager to the firm. The vessel is fitted with double-piston rod direct atting horizontal engines, of 200 nominal and 800 indicated horse-power. Her average speed, with full boiler power, was 10·280 knots per hour; her average number of revolutions 88; her pressure of steam 20lb.; her vacuum 22; and at half-boileg power her average speed 7·692 knots per hour. She turned the half circle in 2 min. 38 sec.; the full circle in 5 min.; w8s stopped in 10 sec.; turned astern in 20 sec.; and turned easy a-head in 5 sec. She carries a Griffith's screw, with a pitch of 14ft., and a diameter 12ft.; her draught of water is 14ft. 3in., both fore and aft. The trial lasted six hours, and is considered one of the most satisfactory which has taken place for some time in Sheerness. The *Rattler* has been recently commissioned by Commander Edward H. Howard, for service in China, and carries twelve 32-pounder and five 40-pounder Armstrong guns, and a crew of 200 officers and men. She will be ready for sea in a few days.

STEAM SHIPPING.

Steam on the Danube.—A prospectus has been issued of the Anglo-Danubian Steam Navigation and Colliery Company, with a capital of £220,000, in shares of £10 each. The Servian Government have granted certain exclusive privileges along the shores of that province, besides a grant of £4000 per annum for five years, and a concession of some coal mines and extensive forests at Dobra, close by the water, which it is alleged can be worked, owing to their peculiar position, at very slight cost. The directors state that from the possession of these mines, and the general facilities afforded to them, they rely upon the ability of the company to give a further great impetus to the rapidly-increasing passenger and produce traffic of the principalities and of Hungary, and also to accelerate the route fron London to Constantinople, *via* the Chernavoda and Kostendji Railway.

Anglo-Italian Steam Navigation Company.—The Italian House of Deputies have voted a bill empowering Government to enter into an agreement with an Anglo-Italian Steam Navigation Company for the conveyance of the mails between Ancona and Egypt. It is calculated that the journey from London to Alexandria, through Paris, Macon, the Mont-Cenis, Turin, Bologna, and Ancona will be shorter by thirty hours than the present route through Paris and Marseilles, in spite of the obstacles thrown in the way of the former line by the Alpine passage of Mont-Cenis, by the slowness of the trains of the Victor Emmanual Company on the Savoy side, and by the jealous contrivances of the Paris andLyons and other French companies striving to further the interests of Marseilles and of the French navigation companies. Within a year the line of railway along the Adriatic coast, from Ancona as far as Brundisi, will, it is expected, be completed, when that ancient port will become the starting place from Italy to Egypt, and the journey of the overland mails will be shorter by fifty hours than it is now by following the Marseilles route.

The "Guadaira."—The following are the dimensions of this screw steamer, recently launched from the building yard of Messrs. Henderson, Coulburn, and Co., of Renfrew. Length 164ft.; breadth of beam 24ft.; depth, moulded, 14ft. She is fitted with direct acting engines of 80 horse power. The *Guadaira* is intended to trade along the Spanish and French Mediterranean coasts. She is the third steamer which Messrs. Henderson and Co. have built for the same destination.

The Steamer "Alliance."—Such is the name of a vessel built on the Clyde on the twin principle. This steamer possesses several peculiarities, the most striking of which is the circumstance that she is built like two boats, with a canal or truck-like space between them, in which the propelling paddle-wheels work entirely out of sight. This construction has enabled the builder to give her comparatively a very large width of deck which he has formed into a wide and spacious saloon. This being above the level of the machinery, and completely covered in with glass, affords passengers ample opportunities of obtaining views without regard to the vicissitudes of the weather.

The "Corcyra," screw steamer, was launched from the yard of Messrs. Richardson and Duck, Stockton, on the 1st ult. The dimensions are as follows:—Length, 203ft.; beam, 28ft. 7in.; depth, 17ft. 6in.; tonnage, 803 tons, O.M. The *Corcyra* has been built for the Anglo-Ionian Steam Navigation Company, and will be supplied with engines of 100 horse-power, nominal, by Messrs. J. Thompson and Co., Newcastle-on-Tyne.

The "Syracuse," (*pro tem.*)—This screw steamer, recently launched from the yard of Messrs. W. Denny and Bros., on the Clyde, is the property of the builders, and is intended for general passenger and cargo traffic. She is 1014 tons, builders' measurement, and her dimensions are 230ft. in length, 30ft. in breadth of beam, and depth, moulded, 19½ft.; full height poop, and topgallant forecastle. Her machinery will consist of two direct acting surface-condensing engines of 200 horse-power, nominal, on Spencer's principle.

The "Lord Clyde." paddle-wheel steamer for the Glasgow and Dublin Steam Packet Company, was launched on the 3rd ult. from the yard of Messrs. Caird and Co., on the Clyde. The *Lord Clyde* is 225ft. long, 26ft. broad, and 14ft. 9in. deep, and measures 770 tons. She will be propelled by a pair of side lever engines of 300 horse-power, to be furnished by the builders, and will be fitted with feathering floats and all the recent improvements.

The "William Connal," screw steamer, has been recently launched from the yard of Messrs. Simons and Co., of Renfrew. This steamer, which has also been engined by Messrs. Simons and Co., is the second vessel of the same name which they have built, the previous one being the first European steamer fitted with wire rigging.

The "Kingstown."—This vessel was recently launched from the yard of Messrs. T. Wingate and Co., of Whiteinch, on the Clyde. The vessel, which is the property of the Dublin and Kingstown Steam Packet Company (Limited), is 153ft. long over all, with a breadth of beam of 20ft., and has steering apparatus at both ends. She has been fitted with diagonal engines of 80 horse-power.

The Hamburg and American Packet Company have given orders to Messrs. Caird and Co., of Greenock, for an iron screw vessel of 2500 tons burthen, and 500 horse-power, nominal. Her dimensions will closely resemble those of a steamer which Messrs. Caird are now building for the North German Lloyd's, and she is to be fitted with surface-condensers, superheaters, Krupp's steel shafts, and other recent improvements. Her length over all will be 360ft.; beam, 40ft.; and depth of hold from upper deck, 36ft. 6in. The engines will be inverted, direct-acting, with cylinders 72in. diameter, and 4ft. stroke. The speed of the vessel, with a 17ft. draught of water, is to be 13 nautical miles per hour. She is the seventh vessel ordered by the Company for their Atlantic line from Messrs. Caird and Co.

MILITARY ENGINEERING.

Fortifications.—Two parliamentary returns have been issued, showing the amount in detail of the sums of money already spent upon, and required to complete, the fortifications in 55 places, of which the centres are Portsmouth, Plymouth, Pembroke, Portland, Gravesend, the Medway and Sheerness, Chatham, Dover, and Cork. The estimated cost of these works is £5,680,000. The estimated expenditure on the works up to the 31st of the present month is £900,000; the amount proposed for 1862-63 is £1,200,000; and the further amount required to complete the work is £3,580,000. The total sum paid for lands is £1,030,000.

Military Stations, &c.—A return has just been issued giving the names of all the military stations in the United Kingdom, including the Channel Islands, and all lands, tenements, and appurtenances at present or within the last twelve years held by the military or ordnance departments, particularising. in a tabular form, the country, name of station, acreable extent of each; tenure, whether in fee or by lease; from whom purchased or rented; date of purchase or lease; amount of purchase-money or rent, and for what term; if sold, or occupation discontinued; to whom sold or surrendered, and on what terms. It appears from this return that the acreable extent of lands or buildings in England is 23,715 acres; the purchase-money, £1,695,064; and the rent, £18,865. In Scotland the acreage is 731; the purchase-money, £40,449; and the rent, £2535. In Ireland, the acreage is 3851; the purchase-money, £261,082; and the rent, £10,834. In the Channel Islands, the acreage is 719; the purchase-money, £115,156; and the rent, £580, giving a total acreage of, in round numbers, 29,021; of purchase-money, £2,111,753; and of rent, £32,644.

The 300-pounder Armstrong Gun, which, since its proof with 90lbs. of powder, has been in a dangerous state, was on the 7th ult. again used at Shoeburyness against iron plates at a range of 200 yards. The target represented a portion of the side of the new class of steam frigates to which the *Minotaur* belongs. In these frigates the armour is 5½in. thick instead of 4½in., as in the *Warrior;* but the thickness of the teak backing is reduced from 18in. to 9in. The inner skin and iron framing are the same as in the *Warrior*. For the first three trials the shot was of cast iron, and the charge was 50lb., as usual. No. 1 struck and pierced the centre plate, damaging but not passing through the inner skin and framing. No. 2 struck the upper plate, and went completely through armour, timber, and skin. No. 3 was directed against the lower plate, and, like No. 2, passed right through the target. The fourth shot was of wrought iron, and the charge the same as before. At this round, however, the gun gave way, the breech being blown backwards to a considerable distance. The gun, however, did not break into fragments, and no one was hurt.

TELEGRAPHIC ENGINEERING.

The Atlantic Telegraph.—The Atlantic Telegraph Company are to be once more assisted by Government. The Admiralty have undertaken to make a new survey of the bed of the ocean between Ireland and America, and will lend vessels for laying the cable. Should the line be laid successfully, Government will further pay the company £14,000 a-year as long as the cable is in working order.

RAILWAYS.

Opening of the Cambridge and Bedford Railway.—The opening of this line, by the passage over it of the directors and shareholders, from Cambridge to Bedford, and *vice versâ*, took place on the 4th ult., and the proceedings were one uninterrupted success. The total length of the line is 29½ miles; its route from Bedford to Cambridge is via Sandy and Potton; and it now, by a direct through route, connects the network of railways of which Cambridge forms the centre in the east, with those of which Oxford is the centre in the west. By the completion of this last link in the chain, a direct Oxford and Cambridge railway is established.

A Safe Railroad.—The New Jersey Railroad Company (Jersey City to New Brunswick, United States, 34 miles) has been organised thirty years, and since the road went into operation upwards of 39,000,000 passengers have been transported over it without the loss of a single life. During the past year alone 3,000,000 of passengers have been carried over this road without any serious accident to any one except those who have either jumped from the trains while in motion, or otherwise jeopardised their own lives by violating the rules of the company.

THE VARNA RAILWAY.—A prospectus has appeared for the construction of a railway from Rutschuk on the Danube, to Varna on the Black Sea, a rival route to the Kostendji and Black Sea line opened only a little more than a year.

RAILWAYS IN INDIA.—From a report under this head, just presented to Parliament, it appears that the progress in the works on the railways in India has been steadily continued during the past year ending the 31st December, 1861. An expenditure of about seven millions sterling has been incurred, and 760 miles of new line have been opened for traffic.

RAILWAY ACCIDENTS.

INVENTION FOR THE PREVENTION OF RAILWAY ACCIDENTS.—M. Grivel, French engineer, has patented two inventions to prevent railway accidents. The first relates to a self-acting apparatus, indicating to the driver of a train if the line is clear, and if a preceding train is at a proper distance or not, and warning him of the same in any weather or season. The second is a new description of break, to stop the disastrous results of a locomotive mounting an incline to which carriages or trucks are attached, paralysing the rupture of the coupling chains, arising either from the too great weight, or from flaws in the manufacture. The invention consists first of a self-acting apparatus, working in the following manner:—The tender or any other part of the train is furnished with an inclined bar of wood, which, by acting on a roller forming part of the apparatus, will move the pointed bar of the apparatus into position to signal a subsequent train that the line is blocked. This apparatus is not disengaged until the train passes beyond the corresponding apparatus placed at distances of three-quarters of a mile from each other, through the entire line, connected to the before-mentioned by a wire. These apparatuses are connected alternately, that is to say, the first to the third, the second to the fourth, and so on. On the locomotive is placed an indicating disc and a bell, which are put in action by means of a crank acted on by the pointed bar before-mentioned, which causes the disc to turn a quarter of a circle, and, at the same time, the clapper on the stem of the disc strikes the signal bell, and warns the engine driver that the preceding train has not passed the apparatus in connection with that which has given the signal of line being blocked. The inventor thinks that it is not prudent to depend entirely on manual power for signalling, as too much zeal on the part of the servants can, as well as of a want of vigilance, be a cause of accident. The action of No. 2, an improvement in railway break apparatus, is as follows:—This improvement consists of a shoe or skid break, which acts automatically on the wheels while on an incline, in case the coupling chains break. The apparatus consists, for a four-wheeled carriage, of two breaks or skids, occupying the whole width of the line, each of them locking the two wheels of the same axle; they are suspended in supports fixed to the axle-boxes; the two skids are connected by a rod passing under the carriage to the coupling chains. The parts are disposed in such a way that when the coupling chains are intact, the skids are suspended; if, on the contrary, they are broken, the skids fall automatically under the wheels, which they lock—so that if a train be ascending an incline, the part of the train detached from the engine will remain stationary on the line, instead of running backwards. These breaks are raised, by means of mechanism, in order to back or otherwise manœuvre the train. By this mode it is easily to be imagined that if any part of the train breaks, neither that nor the inattention of the guard can endanger the lives of the passengers. The action is simple and perfectly self-acting. Also, if a train stops on an incline, for want of power or other causes, it immediately acts as a stop, and prevents the whole of the train from running or sliding back, and does not interfere in any way with the usual manœuvre of backing, and acts as a skid to carriages placed on a siding, and protects them from being blown on to the main line.

BOILER EXPLOSIONS.

ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS, MANCHESTER.—At the ordinary monthly meeting of this Association, on June 24th, Mr. L. E. Fletcher, chief engineer, presented his monthly report, of which the following is an abstract:—"During the last month there have been examined 224 engines—5 specially; 400 boilers —9 specially, 8 internally, 68 thoroughly, and 315 externally; in addition to which 7 of these boilers have been tested by hydraulic pressure. The following defects have been found in the boilers examined:—Fracture, 5 (2 dangerous); corrosion, 43 (7 dangerous); safety-valves out of order, 7; water-gauges, ditto, 11; pressure-gauges, ditto, 6; blow-off cocks ditto, 36; fusible-plugs ditto, 3; furnaces out of shape, 6 (1 dangerous); over pressure, 4; blistered plates, 4; total, 125 (10 dangerous). Boilers without glass water-gauges, 8; without pressure-gauges, 5; without blow-off cocks, 7; without back pressure valves, 26. Advantage has been taken of the very general stoppage of the works during Whit-week to make as many "internal and thorough" boiler examinations as possible, the ordinary routine of visits being entirely laid aside in order that the inspectors might exclusively devote themselves to this special branch. Several cases of extensive corrosion were revealed by these examinations, and which attested to what a dangerous extent they are too frequently postponed. In one instance, the plates at the bottom of a boiler were so reduced in thickness that the engine attendant feared lest the removal of the cake of incrustation should rob them of so much assistance as to prove fatal to the integrity of the shell. I find it necessary again to repeat it is absolutely imperative, if these examinations are to be satisfactory, that the flues should be thoroughly swept, and the boilers suitably prepared, otherwise the condition of the plates cannot be ascertained; while, on the score of economy, I would remark, in passing, that our members can scarcely be aware of the amount of fuel wasted by allowing the plates of their boilers, while in work, to be coated with so non-conducting a substance as soot. Feed water passed through heaters loses 30 degrees of its temperature within a week after sweeping, while the utility of the heater is almost lost if allowed to go unswept for a longer period. This will give some idea of the loss occasioned to boilers by neglect, and I have found the soot to hang from the surface of the plates in complete festoons immediately after the flues themselves had been passed as swept. For some time since I have been desirous of touching upon the point of safe working pressures for boilers, since it not unfrequently happens that it is necessary to warn our members on account of excess. The scale adopted by the Association as a general standard is as follows:—For shells of boilers 7ft. in diameter, made of $\frac{3}{8}$th plate, the safe working pressure 50lb.; if of $\frac{7}{16}$th plate, 60lb.; and other dimensions in proportion. This allowance corresponds with the general practice of the manufacturing engineers of the district, is quite as high as the standard in other parts of the country, and considerably in excess of that permitted either in France, Holland, or Belgium, by their respective governments. It must, however, be distinctly understood that this standard should not be applied arbitrarily in every case, without any allowance being made for the attendant circumstances. It is only applicable in cases where the boiler is well made, both as regards materials and workmanship, and where the condition of the plates is good. It would be highly dangerous to apply it to boilers weakened by the wear and tear of years; while, on the other hand, a new and thoroughly well made boiler might for a time be allowed to work at a pressure slightly in excess of that given. But this could only be safe where everything is in first-rate condition. It is a very common idea that the bursting pressure of a boiler is six times as high as that given above as its safe working pressure. This, however, I am persuaded, is a great mistake, and leads in many cases to undue confidence. I am confirmed in this conclusion by the constant examination of the rent plates in boilers that have exploded, where I find that, even where explosion results from thinning of the plates, rupture ensues long before they are reduced to one-sixth of their original thickness, and in one case I knew a well made and nearly new boiler, in first-rate condition to explode, on account of only a comparatively slight increase of pressure, which had accidentally been allowed through an error in the steam gauge. In this case, that at which the boiler actually burst did not exceed its ordinary working pressure by more than 50 per cent., the one being about 90lb., the other 60lb. I believe that an application of anything like six times the pressure given in the scale above, would burst most of the boilers in Lancashire, and where it has been actually attempted by hydraulic pressure, the steam domes have been found to tear off long before the strain referred to has been attained. I cannot, therefore, think that shells of cylindrical boilers can be worked without risk at a higher pressure than that given in the preceding scale, unless under very exceptional circumstances. With regard to the furnace tubes which are exposed to external pressure, I am glad to find that the practice is becoming increasingly general of strengthening them either with flanged seams or hoops, the hoops being made either of angle iron, T iron, or other approved form; and since it too frequently happens that flues are not made in the first instance truly cylindrical, on which their strength so much depends, and that other sources of weakness creep into the manufacture unawares, it is extremely desirable that no new boiler should be constructed with flues unstrengthened in the way just described, however slight the working pressure may be. These hoops are frequently added to boilers after their first construction, and since some of our members have suffered inconvenience from the imperfect manner in which they have been fixed, I may state the method found by experience to be the best, which is as follows:—The hoops, if made in two halves, may be passed in through the man-hole, and then be secured to the furnace tubes when in position. They should not, however, be brought in direct contact with the plates of the tube, but should have ferrules of about an inch thick placed between the two, so as to leave a clear space all round through which the water can circulate. Where this space has been omitted, the plates have been found in some places to crack at the rivet-holes, and in others to blister and buckle, in consequence of which many plates have had to be cut out and the hoops removed, from which the system of hooping has been in some cases unfairly condemned. Where, however, the ferrules have been introduced and the water space allowed, no injury has been found to arise to the plates even over the hottest part of the fire. The rivets uniting the hoops to the furnace tube should pass through these ferrules, and be spaced about six inches apart, while the two halves of the hoops should be connected together by butt strips rivetted to their ends at the back. When hoops are applied as an after-clap in this way, angle iron is preferable to T iron, as the flange, being narrower, is less liable to cause overheating of the plate. It may be necessary to vary the size of the angle iron in some cases, but, generally speaking, one three inches in the flange and half an inch in thickness will be found to answer every purpose. It is sometimes the practice to put two angle irons back to back. This is quite necessary, and a single one is all that is required.

DOCKS, HARBOURS, CANALS, &c.

AT HINTE, ON THE CHILOA COAST a dock is to be established which will afford great facilities to shipping in general. Many improvements were also in contemplation in the province of Aranco, in order to bring the natives to a civilised life, and to facilitate the navigation of rivers and the establishment of new settlements, in order to extend commerce and industry.

ADDITIONAL ACCOMMODATION FOR THE COAL TRADE AT BIRKENHEAD.—The Mersey Docks and Harbour Board, at a recent meeting, decided, after some discussion, to lay down additional lines of rails and turn-tables for the accommodation of the coal trade at Birkenhead, at a cost of about £4000. Mr. Brocklebank, Chairman of the Committee, from which the proposal emanated, explained that the total amount which had been expended in various grants from the estate to provide facilities for the coal trade at Birkenhead had, up to the present time, amounted to £17,600. On May 2, 1860, a vote was passed by the board to spend £20,000 in affording accommodation for the coal trade, and the £4000 which it was agreed on Thursday to grant would more than extend to that sum, about £2000 having been expended on miscellaneous matters.

ORIENTAL CANAL AND IRRIGATION COMPANY.—An important undertaking in connection with India is announced in the "Oriental Canal and Irrigation Company." The general objects are the construction and maintenance of various works of water transit, in order to improve the navigation of rivers, and to adapt them to irrigation and other profitable purposes. But the particular work proposed to be immediately undertaken is the construction of a navigable canal to connect the Indus at Jerruck with Kurrachee. This will save about eighty miles in distance, much expense, and a great deal of time in the conveyance of goods between Scinde and Kurrachee; it will further irrigate and fertilise an immense district suited to the production of the best cotton, as well as sugar and indigo; and lastly, it will be the means of supplying the entire community of Kurrachee with fresh water. These and other works will be complete in themselves, and thus each successive undertaking will add to the usefulness of the company. The first capital is to be £250,000 in £10 shares, but it is ultimately intended to increase it to £500,000. The chairman of the company is Colonel Grime, and the consulting engineers, Colonel J. F. Smith, late of the Madras Engineers.

GAS SUPPLY.

GAS.—The Boston Gas Company has again declared a dividend of $8\frac{1}{2}$ per cent. The Halesworth Company has declared a dividend of 10 per cent., and a reduction in the price of their gas from 6*s*. 8*d*. to 5*s*. 10*d*. They have also directed a sum of money to be added to their reserve fund. The Worksop Gas Company have declared the full rate of dividends allowed by their act, namely 8 per cent. on old and 7 per cent. on new shares, besides placing a balance to their contingent fund account. The directors have of late years reduced their price from 6*s*. 8*d*. to 5*s*. At Brechin the local company have reduced their price from 5*s*. 5*d*. to 5*s*., and declared their former dividend of 10 per cent.

MINES METALLURGY. &c.

IMPROVEMENTS IN THE MANUFACTURE OF ZINC.—A novel and economic method of treating zinc ores has recently been invented by Mr. Adrien Muller, of Paris, and patented in this country. The zinc is obtained either in a metallic state or as oxide of zinc, by subjecting the ores to be treated in combination with the proper fluxes to an elevated temperature in a suitable reverberatory furnace before introducing such ores and fluxes into the blast furnace, which it is proposed to employ for the reduction and distillation of the ore of zinc, in lieu of introducing the charges in a cold state. The ovens or reverberatory furnaces employed in the preparatory heating of the ores and fluxes are also intended to be used for heating the coke to be supplied to the blast-furnace, special ovens or furnaces being used for that purpose; they are made with two tiers or sets of floors, one above another, and the materials to be heated are first laid upon the upper floor, and gradually raked down through a vertical opening on to the lower and more highly-heated floor, wherein they are finally introduced into the blast-furnace. These ovens should be erected on a level with the mouth of the blast furnace, so that the charges may be introduced into the furnace direct from the ovens, without chilling the same in their transit. The lower portion of the blast furnace should be considerably contracted, as it is essential that a considerable depth of fuel should be maintained in a state of combustion, so as to ensure the entire conversion of the oxygen contained in the air into carbonic oxide, and in order that the furnace should be maintained at a temperature not lower than that temperature which will effect the reduction of the oxide of zinc by the carbon or fuel, and that such temperature shall never become sufficiently lowered so that the reduction of the oxides of zinc shall not be effected by carbonic oxide. The height of the blast furnace should be such as to preserve the necessary temperature up to the part at which the gases are taken off, but at the same time care being taken that the exit of the gases be not low, so as to be effected by the oxidising action of the tuyeres. The exits from the gas should be disposed at the upper portion of the furnace above the charge, so as not to nterfere with the working of the furnace, even when fully charged, and when under the process of distillation. The materials with which the furnace is charged should be previously raised to a temperature sufficiently elevated for the reduction of the oxide of zinc by the fuel or charcoal. Suitable condensers, culverts, and depositing chambers are placed in connection with the blast furnace, so as to allow the gases to deposit the metallic zinc and oxide of zinc, the fixed metals being tapped out from the bottom of the blast furnace. Although the invention is more particularly applicable to the purpose described, phosphoric acid and phosphorus may be extracted from phosphates by a similar process.

SEPARATION OF SILVER FROM COPPER.—Berlandt gives a process for separating pure silver from an alloy of silver and copper. He dissolves the mixed metals in nitric acid, and evaporates the solution to dryness to get rid of excess of acid. He then dissolves an ounce of the salts in five ounces of water, filters the solution, adds fourteen ounces of a solution of protosulphate of iron (five and a-half parts sulphate to eight and a-half parts water), mixes and stirs well. The greyish-white deposit, washed with very dilute sulphuric acid, and afterwards with water, is found to be pure silver.

A COAL CUTTING MACHINE, worked by a compressed air engine, is now in practical operation on the premises of the West Ardsley Coal Company, at their pit on Lingley Moor, near Ardsley. The instrument is applicable to all kinds of pits, whether of coal, ironstone, or fireclay. The engine-house contains a powerful engine, and the compressed air engine, the pressed air itself being conductd in patent bitumenized pipes to a distance of nearly a mile from the bottom of the driving shaft, the pressure being about 50lb. to the inch. The friction is extremely small, the powerful agency being delivered to the cutter in its narrow working almost with the same motive force that it has at the pit head. The cutter itself is a neatly-constructed machine, made to run on the tub-carriage way. It requires a man to direct it, and this tenter can, by working round his wheel advance the pick or cutter over the face of the bed of coal, and thus, in the course of working, bring down the blocks of mineral as he requires them. It is well known that, owing to the fissures in coal seam and the looseness of the roof, streams of gas are plentifully given off in the workings; and this gas is exceedingly troublesome and dangerous to the hewer. If this mischievous gas can be driven away, and the general ventilation of mines improved, the ordinary operation of colliers will be carried on at a considerable advantage, and it is one of the principles of the compressed air coal cutter to accomplish this result. As the cutter is working away with considerable force at the coal, a stream of pure atmosphere is discharged from the machine at every stroke, and this current of fresh and dry air by filling the hole, cannot fail to add considerably to the ventilation.

THE NEW COAL MINE ACT has passed the House of Lords, and it is now compulsory for every coal working to have two means of egress. Nearly three years are allowed for mines at present in work to comply with these provisions, and a clause is inserted to enable this time to be extended and to admit of all necessary exploratory operations. In order, further, to prevent unnecessary inconvenience to the coalowner, it has been provided that where the seam of coal is nearly worked out, and the coalowner is of opinion that the value of the coal to be raised would not justify the outlay, the question may be referred to arbitration; so that it will at once be seen that no unnecessary pressure has been applied.

BORING AND WINDING MACHINERY.—The advantage of careful exploration by boring previous to making a large outlay in mining operations is generally admitted, but there has hitherto been much difficulty in obtaining a cheap and economic machine. Mr. John Paton, of Govan Bar Ironworks, Glasgow, has succeeded in manufacturing a machine, by the use of which the expense of boring is reduced to less than one half of the usual cost. The apparatus has been successfully employed to the depth of 150 fathoms, in the course of which the tools have passed through strata of the hardest nature. Even at this depth the rods and boring-tool were lifted, and wrought with the utmost ease and without strain upon the small engine employed. The services of two men and a boy being all, or indeed more, than is required to carry on the work with speed and efficiency. The rate at which the boring is effected, as well as the extreme facility with which the rods are raised, and the pump lowered to clear the bore, enables the workmen to accomplish a very large amount of work in a given time, as compared with the old system. It is found in practice that one machine will do the work of ten or twelve men. The mechanical arrangement is extremely simple. Upon the foundation frame of the machine is arranged a small engine, which gives motion to the shaft. On the shaft, at the end nearest to the engine, is fitted a pinion, which is preferred to be of the angularly-grooved frictional class; this pinion imparts motion to the grooved wheel, which is keyed to the transverse shaft. In fitting this shaft, its journals are arranged eccentrically in the bearings, which are carried in the pillars of the framing, one of the bearings is made to project sufficiently to admit of the eye of the hand lever being passed on to it and attached thereto. With this arrangement, when the hand lever is raised the shaft is lowered sufficiently to throw the wheel out of gear with the pinion on the shaft, which comes down on a break-block beneath. It is by means of the wheel that the necessary vertical, intermittent, or jumping motion is imparted to the boring tool. In two of the arms of the wheel are formed radial slots, in which are fitted the adjustable studs carrying the anti-friction rollers. The studs project inwardly from the face of the wheel, so that as the wheel rotates the rollers alternately come into contact with and depress the end of the lever. This lever is fast to a short horizontal shaft, the bearings of which are carried on the upper part of the framing. To the shaft is keyed a second lever, to the free overhanging extremity of which is suspended a swivel, and the brace-head or hand-wheel, for giving a rotatory motion to the boring-rods and the boring-tool at the lower end of the series. The weight of the rods on the lever is counteracted to the required extent by an arrangement of a counterweight used in conjunction, if required, with a hydrostatic or pneumatic cylinder. On the foundation frame are arranged the pedestal bearings of the transverse shaft, which has fast to it a lever connected by a chain to the counterweight. In front of the framing is fitted a spring buffer apparatus, which serves to modify the force of the blows, more particularly when a new boring-tool is brought into use, and it is required to make the blows of the tool comparatively light. The foundation frame supports the lofty frame, to the cross-beam of which are hung two pulleys; over one of these the chain for lifting the rods is passed, and over the other the wire-rope for lowering and raising the pump. The arrangement of the frame is to facilitate the raising of the rods, to save time and avoid taking the rods apart, except in lengths of 30ft.; and the frame is made of a height to admit of the rods being disconnected in such lengths. The shaft has running loosely upon it the drum or barrel, which is put into and out of gear with the shaft by means of a coupling-clutch, actuated by a hand lever. This drum is used for the wire-rope for raising and lowering the pump, to afford the necessary convenience for cleaning the bore when required. The rotatory movement of the drum is checked and regulated by a friction-strap, which is tightened by the handle. The boring-rods are raised and lowered, and other winding operations performed, by means of a chain wound upon a secondary barrel, actuated from the first motion shaft. This shaft has upon it a second frictional pinion, which gives motion to the wheel on the shaft; the journals of this shaft are arranged eccentrically in their bearings, as before described in referring to the shaft. In this way, by means of a hand lever, the wheel may be instantly put into or out of gear with the pinion. The shaft has fast to it the winding-barrel, on which the rope or chain for effecting the winding operations is wound. With these arrangements either of the winding-barrels may be brought into operation as required, or remain quiescent, whilst the wheel is operating the lever and the boring tool. When the hole has become so choked with the fragments that it would impede the action of the borer, the rods are raised with the greatest facility, and separated in lengths of 27 to 30ft. each; the whole is then cleared with the pump attached to a wire-rope, and the rods are replaced, the entire operation occupying but a very few minutes.

APPLIED CHEMISTRY.

PRESENCE OF XANTHIC OXIDE IN GUANOS CONTAINING NO URIC ACID, BY DR. T. L. PHIPSON.—Some specimens of guano that have lately been forwarded to me for analysis, and which are known in commerce as Jarvis Island Guano, West India Phosphate, &c., have presented a peculiarity which renders them interesting. They contain no uric acid, or, at least, in some specimens only an exceedingly minute trace of uric acid, whilst a notable amount of xanthic oxide is present in them. The want of uric acid explains why these kinds of guano only yield 0·46 per cent. of nitrogen, equal to half a per cent. of ammonia, and are consequently very inferior in an agricultural point of view to pure Peruvian guano. Xanthic oxide, $C_5H_2N_2O_2$, formerly discovered by Dr. Marcet, in a small human calculus, was found in guano some years ago by M. Unger. In a sample of the variety of guano mentioned above I have extracted xanthic oxide in the following manner: The guano was mixed with a solution of caustic soda, boiled once or twice, and filtered. Through the filtered liquid a current of carbonic acid was passed for several hours, when all the xanthic oxide was precipitated as a white powder, exceedingly fine, and remaining for a long time suspended in the liquid. It can, however, be readily collected upon a filter. The following is the analysis of a sample of this kind of guano, in which not a trace of uric acid could be detected:—

Moisture	1·00
Xanthic oxide, $C_5H_2N_2O_2$	0·25
Brown organic matter	16·25
Phosphate of lime	35·50
Carbonate of lime	34·00
Sand	12·00
Chloride of sodium and loss	1·00
	100·00

Nitrogen 0·46 equal to ammonia 0·55 per cent. The xanthic oxide extracted as above gave all the reactions indicated by Marcet and Berzelius.

ON MORPHIA, BY JOHN HORSLEY, F.C.S.—In addition to the nitro-prusside test for morphia already mentioned, I have to notice another peculiarity of morphia,—viz., the rapidity with which it reduces nitrate of silver. If one drop of solution of acetate or sulphate of morphia (1 per cent. strength) be mixed with ten or fifteen drops of a solution of nitrate of silver (four grs. to the drachm), and agitated for a minute or so, a fine white crystalline precipitate of frosted silver shortly takes place, the liquor acquiring a slight yellow colour (from the reaction of the liberated nitric acid upon the morphia, and on decantation or filtration and the addition of strong nitric acid the usual orange-red colour of morphia is developed. If a white porcelain dish, containing the nitrate of silver solution, be slightly warmed previous to adding the morphia, the reduction is almost instantaneous, and the vessel coated with a film of silver. I have not noticed a similar reaction with other alkaloids, so that this peculiarity entitles it to a place amongst the ordinary tests for morphia given in our toxicological works. I consider it quite as delicate and unexceptionable as iodic acid, which was generally considered the most sensitive test. Gallic and tannic acids need never lead to any confusion with morphia, as their reaction upon silver solutions is very different, an intense muddy-black or brownish-black colour being produced almost immediately, and a flocculent precipitate forms, which is not the case with morphia, to say nothing of the other characteristics by which they are readily distinguished.

ON THE GENERAL OCCURENCES OF TITANIC ACID IN ALL CLAYS, AND ITS FREQUENT OCCURRENCE IN IRON ORES, &c.—Mr. Riley lately read a paper upon the above subject before the Chemical Society. He pointed out that until recently titanic acid had been known to the chemist only as a rare substance, and very seldom to be met with. The metal titanium (or more correctly speaking, the nitride and cyanide) is found more or less in the old hearths of all blast-furnaces, frequently in beautiful, well-defined cubical crystals, and at times massive, like copper (a sample of the crystals quite pure, and weighing nearly a pound, was exhibited). The author had seen the old hearths of about 30 blast-furnaces, and he was always able to find the crystals; in some cases they were small, but usually, where a superior quality of iron was made, the titanium occurred in large quantities, and in well-defined crystals. From the universal occurrence of the metal in the old hearths, it was obvious that it must be an element pretty generally diffused, and the results of his investigations, extending over some years, had convinced him that it occurred more or less in all clays, in many soils, iron ores, &c. The following were the results of the examination of the principal fire-bricks used in London:—

Makers' name and locality.	Silica per cent.	Titanic acid p. ct.
Stourbridge—Hickman	65·11	1·05
" Rufford	63·42	1·05
Newcastle—Stephenson	60·60	·42
" Lucas	60·49	·60
" Ramsay	55·68	·67
Yorkshire—Wortley, Ingham, and Sons	62·96	·96
North Wales—Hawarden	62·39	·69
South Wales—Dowlais	63·02	1·04
Surrey—Yellow clay, dry at 212°	64·52	·50
South Wales—Dinas	94·43	—
Surrey—Ewell	91·84	—
Devonshire—Black Alder	75·16	—

The author considered the last three bricks to be silica bricks, and not clay. Besides the above, mine shales and various other clays had been examined, in which its presence was detected, but no quantitative determination made. The difficulties of estimating and detecting titanic acid were very great, and it was only recently that they had been overcome—the general reasons were its similarity to alumina in some of its properties, and to silica in others. It had hitherto been estimated with either of the above substances, and, moreover, the presence of iron in solution prevented its precipitation in the ordinary way, the titanic acid being weighed with the iron, and increasing its weight. The author then alluded to the determination of titanic acid in iron ores and products from ironworks, and the analyses of iron ores generally, and pointed out the frequent errors made, more especially in the determination of iron, from the presence of phosphoric acid and titanic acid. With some samples of English pig-iron in the Exhibition, and the iron ore from which it was smelted, analyses were given in which no phosphoric acid was mentioned; this ore had been examined by pulverising about 3 cwts. taken from different parts of the mine, and found to contain 1·80 per cent. of phosphoric acid, and two samples of the pig gave respectively 1·75 and 1·80 per cent. of phosphorus. Titanic acid ought to be classed as one of the ordinary elements, as it occurs most frequently, the acid is also found in nearly a pure state. The occurrence of titanic acid in pig-iron was adverted to—it had on one occasion been detected, but as to its influence on the quality of iron and steel, the author was conducting some experiments upon the subject, and could not at present speak definitely upon the matter.

APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTIZAN."

DATED JUNE 24th, 1862.

1849 A Ripley—Improvements in the construction of damper governors or regulators.
1850 W. Hargreaves and J. H. Leather—Improvements in combing wool, hair, silk, cotton, flax, and other fibrous substances.
1851 T. Carr—Grinding, kneading, and washing.
1852 T. Desgraudschamps—Distribution with motion from the rod, applicable to any kind of steam engines.
1853 G. Collier and W. Crossley—Hot pressing.
1854 W. Baylis—Tightening wire for fencing.
1855 J Johnston—Hats.
1856 G. Gray—Wheels.
1857 E. C Nicholson—Colouring matters applicable to dyeing and printing.
1858 W. Clark—Hernial and other orthopedic apparatus.

DATED JUNE 25th, 1862.

1859 M. A. F. Mennons—Steam boiler furnaces.
1860 S. Brooks—Spinning and doubling.
1861 J Blair—Manufacture of wadding.
1862 W. Clark—Ploughs.
1863 G. Haseltine—Vaporising lamps for burning petroleum or coal-oil.
1864 F. Tolhausen—System of locks.
1865 A. Bayley—Lamps.
1866 C. C. Steenstruf—Can or vessel.
1867 E. H. Huch and F. J. Winchausen—Fire air engines.
1868 J Whitham—Working oil and other hydraulic presses.
1869 G. Turner—Grinding coffee and spices.
1870 J. David—Ascertaining the relative strength and elasticity of various kinds of thread and ropes.
1871 W. Clark—Frame for holding photograpic pictures.
1872 W. Clark—Apparatus for raising the nap on cloth and other fabrics.

DATED JUNE 26th, 1862.

1873 E. T. Hughes—Regulating or moderating the movement of the keys of piano-fortes.
1874 G. Peterson—Apparatus for ascertaining the quantity and strength of spirits.
1875 T. R. Tebbutt—Manufacture of soap, soda, and other material employed for the purpose of washing and cleansing.
1876 J. Parkes—Gas lanterns.
1877 J. B. Coquatrix—Weaving carpets, tapestry, and similar fabrics.
1878 J. Martin—Reaping and mowing machines.
1879 J. H. Johnson—Electro voltaic plate work for medical and other purposes.
1880 J. H. Johnson—Fluids for illuminating purposes.

DATED JUNE 27th, 1862.

1881 A. Anderson—Apparatus for steering ships and other vessels.
1882 J. Watson—Printing sheets of paper from letter-press forms, stereotype blocks and wood engravings.
1883 C. Cochrane—Manufacture of aluminate of soda and potash.
1884 E. Hunt and H. D. Potash—Condensing Apparatus.
1885 C. Cochrane—Manufacture of iron.
1886 J. Lord—Power looms for weaving.
1887 W. Owen—Manufacture of woven tickets of silk, cotton, or wool.
1888 R. A. Brooman—Methods of preparing paper for the reception of photographic pictures.
1889 A. H. Martin—Means or apparatus employed in weaving.
1890 I Holden—Means or apparatus for preparing and combing wool.
1391 A. A. Croll—Treatment of ammoniacal liquor of gas works.
1892 D. L. Banks—Apparatus for facilitating operations under the water, in the water, or out of the water.
1893 D L. Banks—A portable sectional dry rock.

DATED JUNE 28th, 1862.

1894 M. A. F. Mennons—Apparatus for the prevention and reduction of synovial and other swellings or tumours in the limbs of horses
1895 T. King and J. King—Agricultural machines.
1896 C. Beslay Galvanising or coating metals.
1897 G. H. Hulskamp—Pianofortes.
1898 J. Garnier—Ordnance and projectiles.
1899 G. W. Belding—Flexible spring cloth or fabric.
1900 C. Callebaut—Sewing machines.
1901 J. Tatham—Apparatus for preparing, spinning, doubling, and winding cotton and wool.
1902 J. Prrie—Slide valves for steam engines.
1903 J. Webster—Protecting steam boilers from incrustation.
1904 N. Thompson—Apparatus for stopping bottles, jars, and other vessels.

DATED JUNE 30th, 1862.

1905 J. Wall and T. Dodd—Taps for controlling the flow or passage of fluids
1906 W. Thomas—Running gear of four-wheeled carriages.
1907 J. Hartshorn—Manufacture of lace.
1908 A. Byrnes—Breech loading fire-arms.
1909 W. E. Gedge—Looms for weaving.
1910 W. F. Murray—Manufacture of stoneware
1911 W. E. Newton—Apparatus for picking or gathering cotton.
1912 W. Easton and George Donkin—Lears or annealing chambers
1913 T. Parker—Tinting or dyeing fabrics.

DATED JULY 1st, 1862.

1914 J. Parkinson and J. Marsland—Apparatus for regulating the flow and pressure of steam and other fluids.
1915 E. F. Prentiss—Omnibuses and other vehicles.
1916 E. Pourpoint—Wool washing machine.
1917 R. A. Brooman—Construction of blast furnaces.
1918 C. Lungley—Constructing, building, and working floating docks and other floating bodies.
1919 G. H. Birkbeck—Processes for the utilization of certain refuse products resulting from the manufacture of iron.
1920 J. Greenhalgh and James Greenhalgh—Diminishing valve.
1921 T. Fellowes and H. Hemfrey—Apparatus for elevating straw and other agricultural produce.
1922 J. M. Dunlop—Cotton gins.
1923 W. E. Newton—Machinery for washing wool.

DATED JULY 2nd, 1862.

1924 E. D. Lebastida—Manufacturing india-rubber articles.
1925 W. Porter—Manufacture of targets.
1926 J. James—Welding railway crossings.
1927 Looms for weaving.
1928 B. Johnson—Rope wheels for mines and collieries.
1929 T. L. Atkinson—Stew pans.
1930 G. H. Hulskamp—Violins and other stringed instruments.
1931 J. Murray—Portmanteaus.
1932 J. Steel—Waterclosets.
1933 J. Crisp and W. Elliott—Apparatus for burning American rock oil, paraffine oil, and oil of petroleum
1934 J. Webster—Manufacture of gas for illumination.
1935 G. Bedson—Rolling wire and other rods or bars of metal.
1936 J. M. Hetherington and T. Jackson—Apparatus for preparing, spinning, and doubling cotton.

DATED JULY 3rd, 1862.

1937 T. Turner and William Taylor—Single and double breech-loading fire-arms
1938 G. H. Birkbeck—Construction of mechanical horses.
1939 W. A. Gilbee—Manufacture of blue colouring matter.
1940 W. M. Williams—Apparatus for the distillation of coal and peat.
1941 T. Edmonds—Preparing compressed fruits in cakes.
1942 T. O. Dixon—Apparatus for heating or warming rooms.
1943 J. Miles—Machinery for cutting out soles and other parts used in the manufacture of boots and shoes.

DATED JULY 4th, 1962.

1944 S. Russell—Stereoscopes
1945 W. J. Cunningham—Sewing machines.
1946 A. Drevelle—Apparatus for laying cards or sheets of metal into woven or textile fabrics ready for the press.
1947 S. Witham—Manufacture of iron and steel.
1948 J. Howard and J. Bullough—Warping and beaming machines.

DATED JULY 5th, 1862.

1949 H. Rushton—Covering crinoline steels.
1950 R. A Brooman—Hollow plates for hydraulic presses.
1951 O F. Byström—Pyrometer.
1952 C. G. Hill—Apparatus for producing ornamental patterns or figures and attaching them to lace
1953 A. Warner—Materials for purifying coal gas.
1954 P. G. O'Neill—Screw wrenches or spanners.

DATED JULY 7th, 1862.

1955 J. Kidd—Gas meters.
1956 C. Wessely—Carriages.
1957 T. Edwards—Movement for the indices for gas, water, and other fluid meters.
1958 J. McGeary—Manufacture of gas.
1959 J. P. Booth—Manufacture of feather beds quilts, bolsters, and pillows

DATED JULY 8th, 1862.

1960 W Spence—Telegraphic Apparatus.
1961 J. H. Johnson—Wet gas meters
1962 C. o. Gruner—Photographic apparatus.
1963 J. Brown—Motion for actuating the doffers of carding engines
1964 J. Russell, jun—Arrangement and method of indication to be employed in time tables.
1965 C. Stafford—Trimmings, tufts, and other articles for ornamental and decorative purposes.
1966 J. Rigby—Breech loading guns.
1967 O. W. Child—Useful composition to be used in shaft journal boxes.
1968 J. Bourke—Military accoutrements
1969 H. Wetherd—Construction of handles, latches or fastenings for doors, gates, and windows

DATED JULY 9th, 1862.

1970 W. L. Wigginton—Smoky chimnies.
1971 J. M. Gillie—Calendar inkstand
1972 T. C. Gibson—Construction of and vessels for for the purpose of carrying and warehousing petroleum, palm oil, and other oils or inflammable fluids.
1973 A. Gilbey—Apparatus for washing and cleansing bottles.
1974 H. S. Pontifex—Apparatus for distributing water.
1975 J. Rhodes—Rag machines.
1976 C. F. W. Rust—Concertinas and other wind instrumepts of that class.
1977 H. Eschwege—Purifying wood and other vinegar.
1978 G. T. Bousfield—Washing machines.
1979 E. S. Hindley—Apparatus used when circulating hot water for warming dwelling-houses.
1980 T. Green and T. R. Mathers—Steam boilers.
1981 S. V. Evers—Preparation of beverages.
1982 J. O. Butler—Steam hammers and framings therefor.

DATED JULY 10th, 1862.

1983 W. F. Reynolds—Watch pendant.
1984 E. Jaudeau—Removing the bad flavour distilled from grain, beet root, or other vegetables.
1985 H. Kellogg—Breach loading fire-arms.
1986 J. Mander—Crochet needles and crochet needle owners.
1987 A. Bonnel—Churns.
1988 J. Ponti—Apparatus for viewing photographic pictures.
1989 E. J. Biddle—Use of petroleum or coal oil as fuel.
1990 E Townsend—Useful invention for making nails, and driving such nails into the sole of a boot or shoe.
1991 J. Leeming—Jacquard or index machines.
1992 D. Steele—Method of flushing or distributing water in pans or basins applicable to waterclosets and urinals.
1993 T. Farra—Wearing apparel.
1994 J. H. Johnson—Braiding machines.

DATED JULY 11th, 1862.

1995 J. Reid Hill—Governor for the engines of steam vessels
1996 M. Cornall and E. Griffiths—Doubling, twisting, and reeling threads and yarns of cotton.
1997 J. Waithman—Apparatus for carding flax and tow.
1998 W. Ashton—Machinery employed in the manufacture of braids.
1999 J. Orr—Weaving piled fabrics.
2000 J. Miller—Apparatus for steering ships.
2001 W. Bliss—Heating ores.

DATED JULY 12th, 1862.

2002 C. E. Green and J. Green—Breach-loading fire-arms.
2003 J. [illegible] Lees and J. Beard—Carding engines.
2004 J. Abraham—Presses for raising or shaping materials.
2005 J. Hunt—Process of sizing and drying yarns or threads.
2006 M. A F. Mennons—Vessels mounted as floating batteries.
2007 T. Hill—Arrangements employed for the protection of markers at rifle-butts.
2008 E. T. Hughes—System of winding or rolling silk thread on moulds or bobbins.
2009 J. H. Jonson—Apparatus for washing ores and minerals.
2010 W. E. Gedge—Manufacture of hats.
2011 P. Plassan—Orthopedic apparatus.
2012 D. Bateman—Manufacture of card cloth.
2013 H. Barber and H. De Garrs—Rolling iron, steel, and other metals.
2014 Hon. W. E. Cochrane—Railway fastenings.

DATED JULY 14th, 1862.

2015 E. Taylor—Manufacture of buttons.
2016 G. Lowry—Machinery for carding and cleaning cotton.
2017 W. E. Gedge—Portable or stationary steam lift and force pump.
2018 A. A. Ganual—Manufacture of bituminous cement.
2019 C. Crossley and J. W. Crossley—Apparatus employed in washing and finishing textile fabrics.
2020 S. Partridge—Railway signals.
2221 P. Sanderson and R. Sanderson—Manufacture of woven fabrics.
2022 W. G. May—Apparatus for extending tables.
2023 P. A. L. Canonicat—Filtering water.
2024 G. Fawcus—Building boats
2025 F. M. Parkes—Manufacture of gas for lighting and heating.
2026 O. P. Drake—Apparatus for vaporizing and aërating a liquid hydro-carbon.
2027 R. Ridley and J. G. Jones—Apparatus for ventilating mines.

DATED JULY 15th, 1862.

2028 A. Leslie—Apparatus for applying steam or other motive power to cultivate the soil.
2029 A. Couvreux—Apparatus for breaking stones.
2030 J. Green—Means of producing signals.
2031 A. Couvreux—Apparatus for throwing stones, and earths.
2032 E. Draper and E. Thomas—Strengthening wood shutters and doors.
2033 W. Dickens and J. Hewitt—Self-acting and hand mules.
2034 C. E. Crawley and F. Foster—Safety or miners lamps.
2035 T. G. Ghislin—Preparation of British and foreign algæ.

DATED JULY 16th, 1862.

2036 B. Johnton and E. H. Taylor—Rope wheels, cages, and tanks used for mines, collieries, and other similar purposes.
2037 G. T. Selby—Apparatus for superheating in in tubes and tubular articles.
2038 L. R. Bodmer—Apparatus for winding up watches and other time keepers.
2039 W. Henson and W. Williams Clay—Knitting machinery
2040 A. V. Newton—Sewing machines.
2041 C. Sanderson—Manufature of crinoline or crinoline steel
2042 R. Dunn—Furnaces.
2043 M. Kurts—Manufacture of handles for umbrellas, parasols, and walking-sticks.

DATED JULY 17TH, 1862

2044 J Dickson—Manufacture of caustic soda and carbonate of soda.
2045 H. Appleby—Armour plates for ships of war.
2046 J. G. Harness—Safety handle for winches and cranes
2047 J Schloss—Pouches.
2048 T. B. Daft—Manufacture of mats.
2049 T B. Daft—Manufacture of vulcanized india rubber thread.

DATED JULY 18th, 1862.

2050 W. Cossage—Decomposition of chloride of sodium and chloride of potassium.
2051 J. Wilcock—Ornamental fabric.
2052 O. F. Morrill—Apparatus for generating heat for culinary or various other purposes.
2053 F. L. Stott—Apparatus for warping yarns or thread.
2054 J. R. Abbott—Chandeliers, gaseliers, and other pendant lamps.
2055 J. S. Jarvis—Shirt collars.
2056 R. A. Brooman—Heat in furnaces and fireplaces.
2057 C. A. Day and Thomas Summers—Sheer legs.

DATED JULY 19th, 1862.

2058 A. B. Brown—Steam engines and boilers.
2059 G. J. Yates and J. W. W. Tindall—Deodorizing paraffin coal, pitch, rock, and other like oils and hydro-carbons
2060 R. Barrett—Apparatus for working the damper of steam engine furnaces.
2061 R. A. Brooman—Revivifying animal black.
2062 A. Cotelle—Manufacture of alcohol.
2063 A. Pratt—Self-capping fire arms.
2064 W. E. Newton—Ordnance and projectiles for the same.
2065 W. E. Newton—Machinery for preparing fibrous substances for combing
2066 T. H. Saunders and J. Millbourn—Manufacture of paper
2067 W. Tranter—Fire-arms.

DATED JULY 21st, 1852.

2068 C. Ramsay—Military cloak.
2069 J. W Green—Method of cutting sheet and plate glass to any given design.
2070 E. Bazin—Electric railway carriage signal.
2071 W. E. Gedge—Excavating or boring apparatus.
2072 T Davey—Manufacture of gunpowder and explosive compounds
2073 A. M. Fell—Sulphate of ammonia and manure.
2074 A. Naudain, J. Peacock, and W. H. Walton—Looms for weaving.
2075 W. Clark—Pomade or balsam.
2076 A. Phillips—Looms for weaving figured fabrics.

DATED JULY 22nd, 1862.

2077 T. Meriton—Steam engine governors.
2078 S. Lord—Carding engines
2079 P. F. Cassegrain—Fire-arms.
2080 A. Fournier—Manufacture of easy chairs, railway and carriage seats.
2081 Dr. W. Smith—Power looms for weaving.
2082 J Daniels—Artificial manure.
2083 R. Grogan—Screw propeller steam vessels.
2084 W. E Gedge—Marking wadded or other stuffs.
2085 W. Crofts—Manufacture of fabrics by lace machinery.
2086 H. R. Summons—Bordering envelopes, paper, and cards
2087 H. R. Summons—Bordering envelopes.
2088 T. King—Measuring malt, grain, and other granular substances.
2089 G. Payne—Hore shoes.
2090 J. H Johnson—Treatment of noxious gases in the distillation of tar
2091 A. C. Vautier—Obtaining fibrous materials for manufacturing paper pulp.
2092 J J. Hayley—Machine for washing.

DATED JULY 2[illegible]rd, 1862.

2093 C. J. Keene—Raising and lowering canvas.
2094 Z. Colburn—Condensation of steam.
2095 E. K. Dutton—Steam engines
2096 A. Vignon—Extinguishing fires on land or water.
2097 W. Clark—Manufacture of manure.
2098 E. Alcan—Combing and carding wool.
2099 R. Bell—Manufacture of bricks.

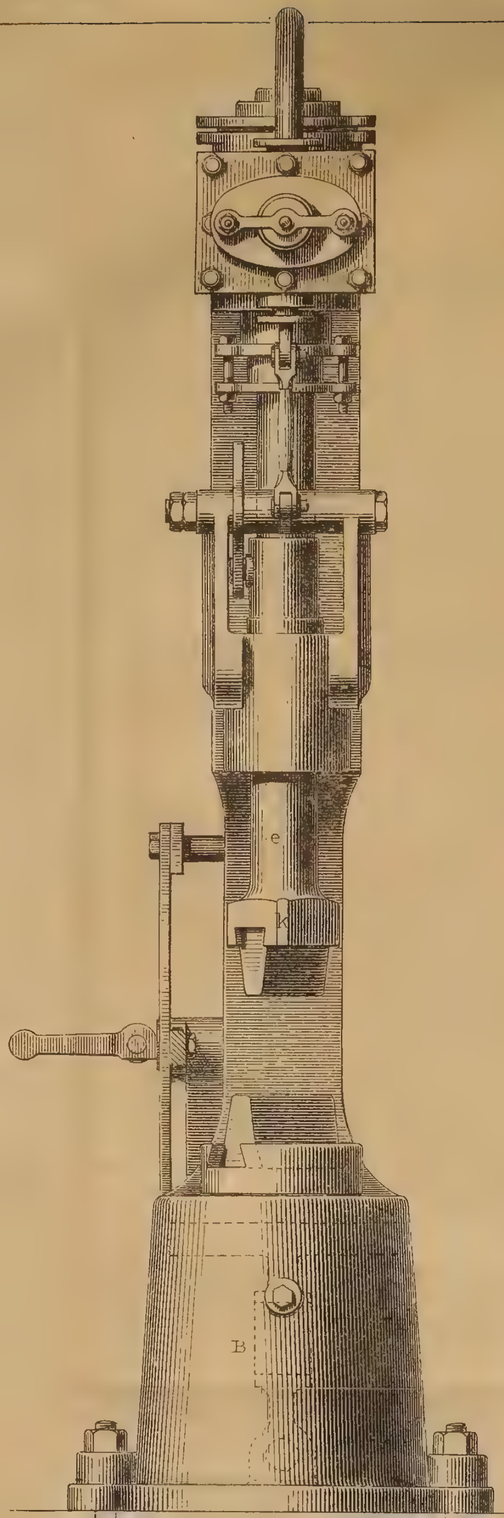
DATED JULY 24th, 1862.

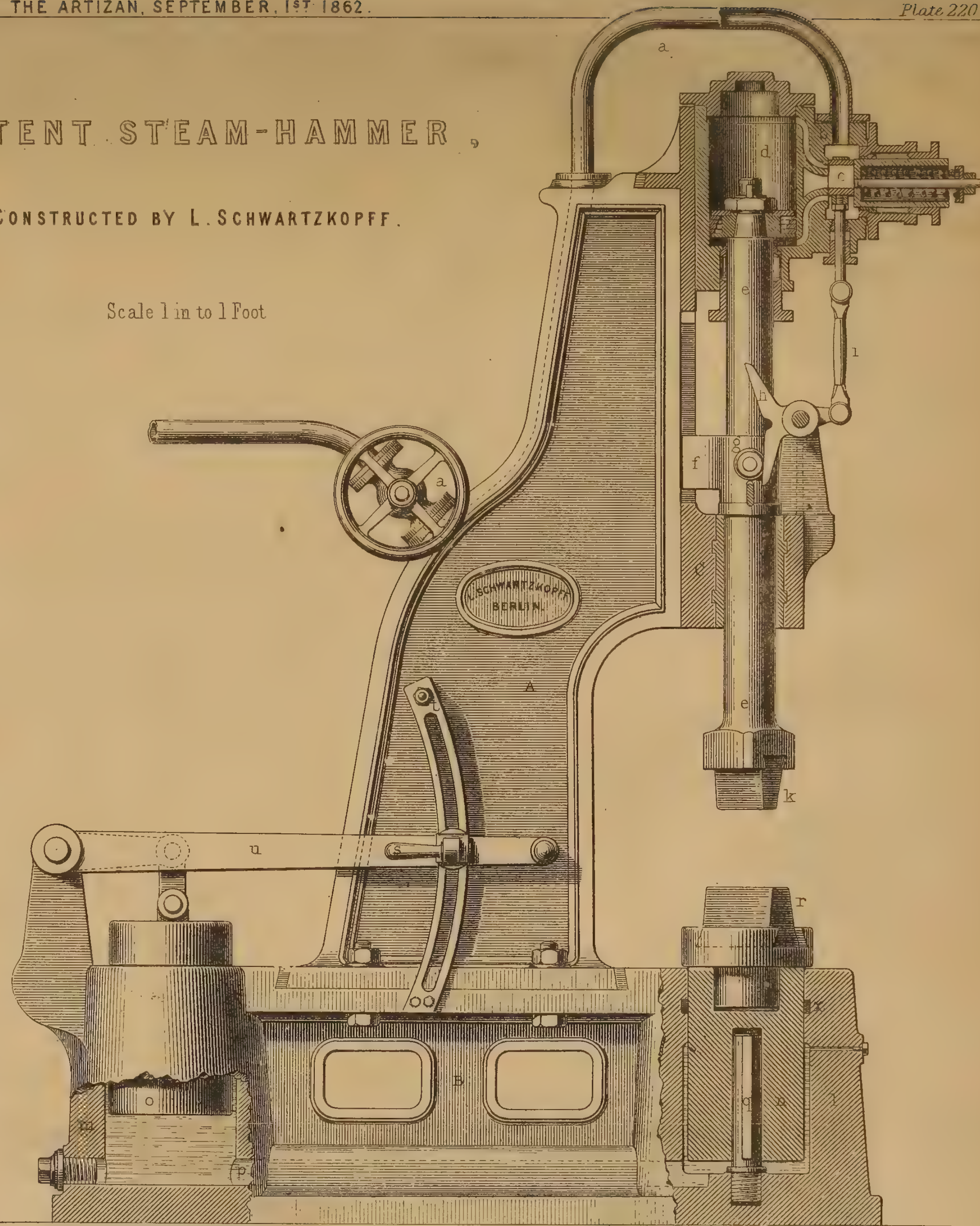
2100 J. Leetch and B. Matthew—Protecting the surfaces of iron and other metals.
2101 J. Dickson—Treating copper ores.
2102 J. Horton—Breech-loading fire-arms.
2013 W Clissold—Cylinders.
2014 H. Rawson and F. Staples—Combing wool.
2105 T. Lemaistre—Privies.
2106 J G Clarke—Scythes
2107 W. H. Perkin—Printing and dyeing.
2018 W. Clark—Fishing and other nets.
2019 M. Henry—Retarding and stopping carriages.

PATENT STEAM-HAMMER,

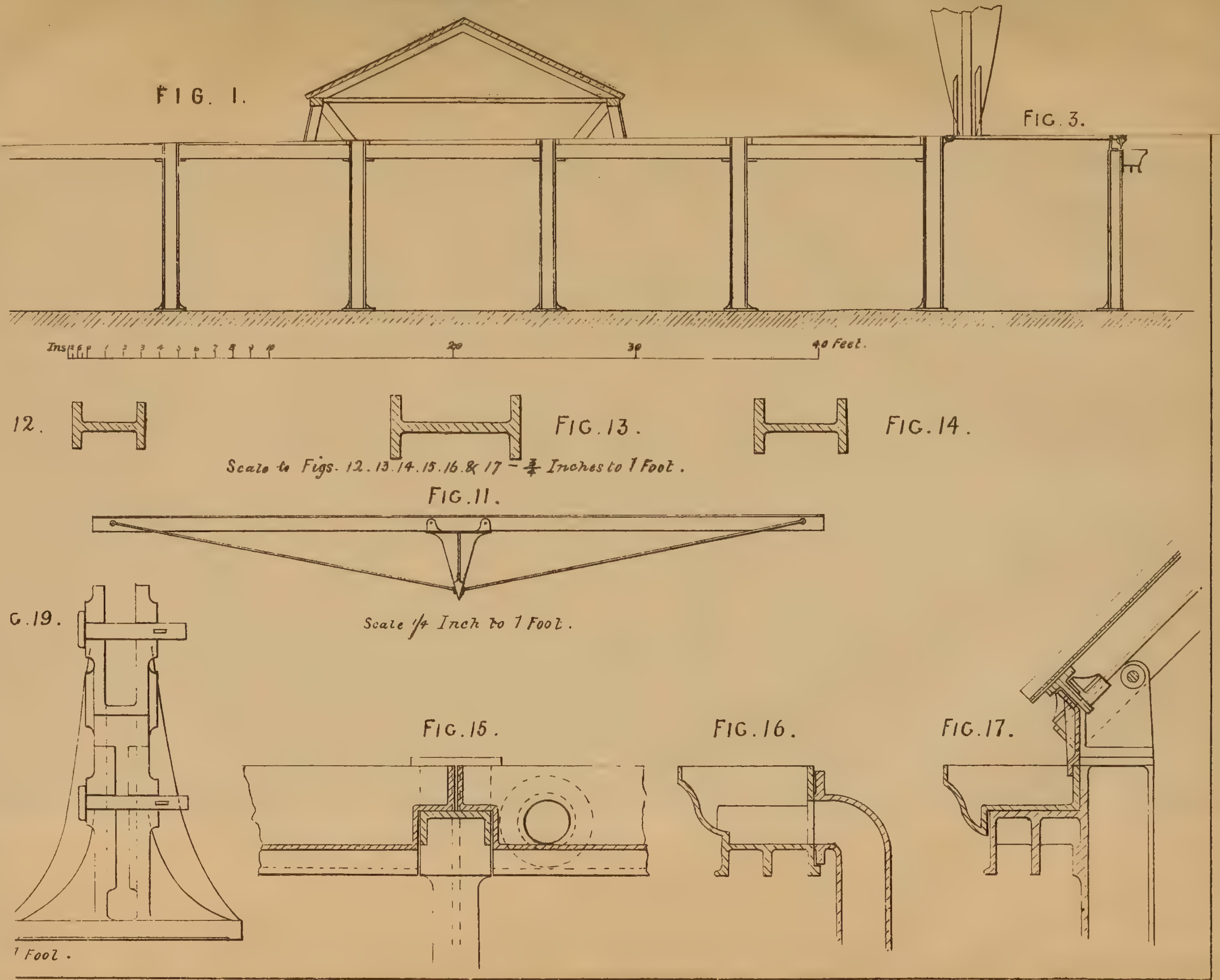
CONSTRUCTED BY L. SCHWARTZKOPFF.

Scale 1 in to 1 Foot

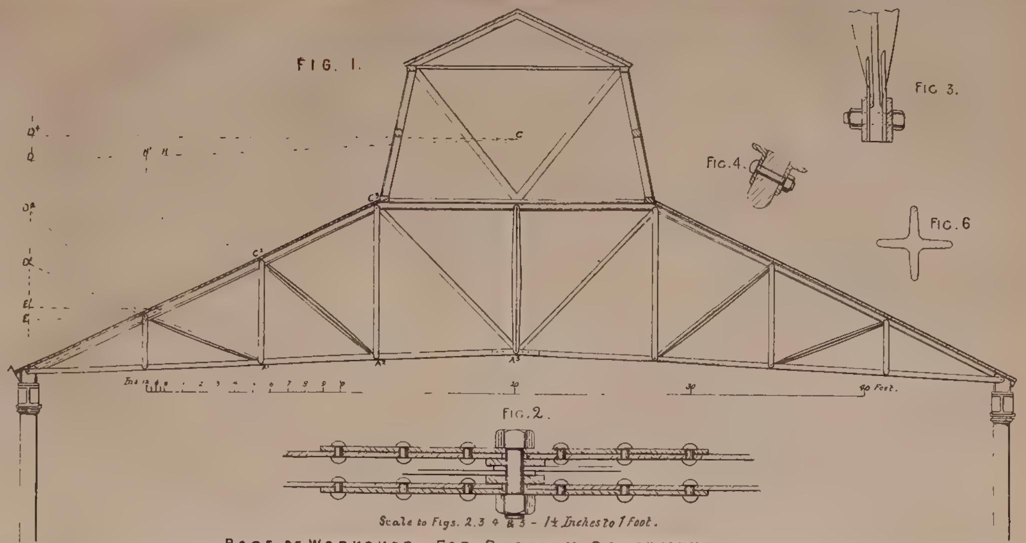




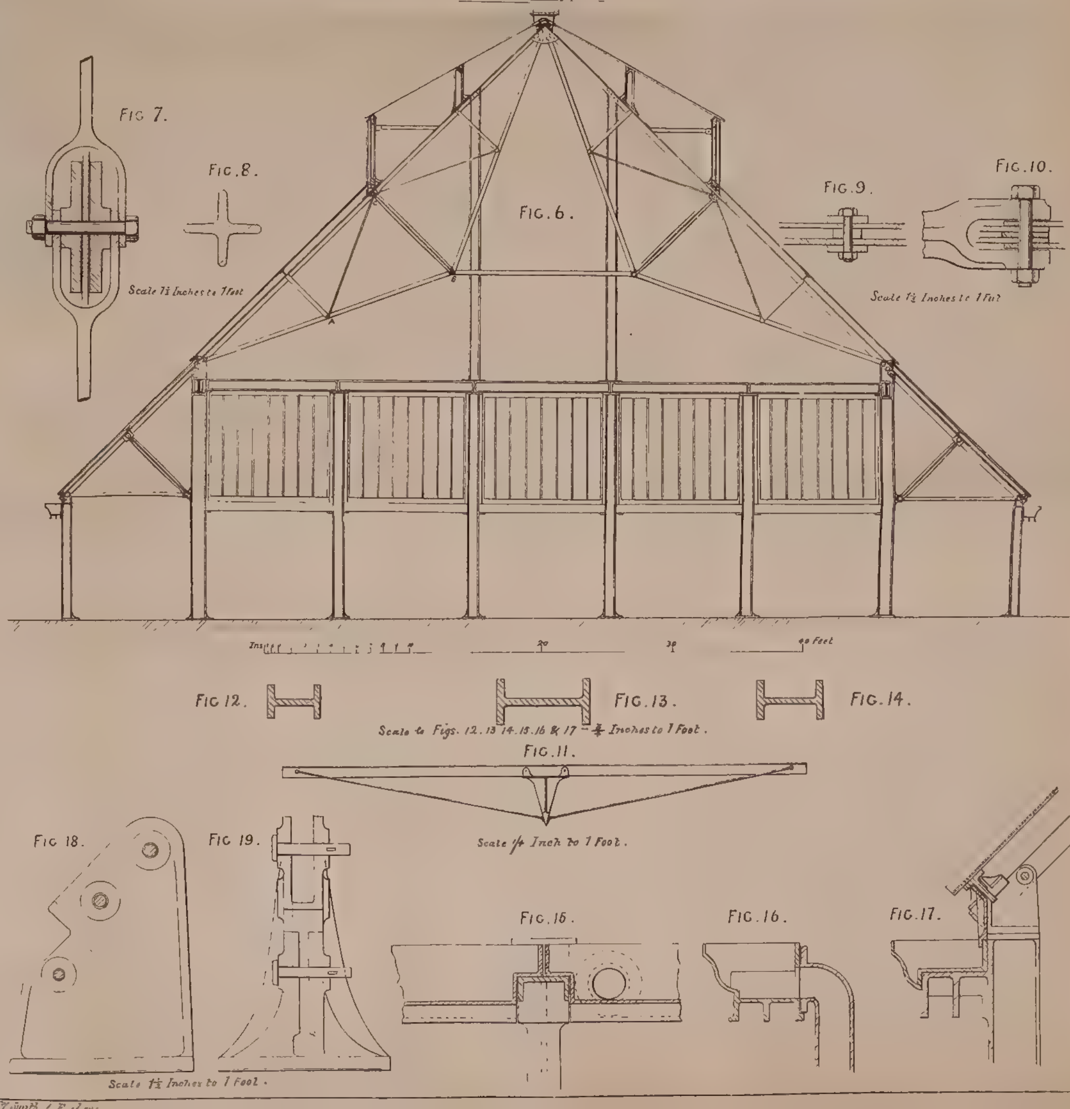
ROOF OVER LONGTON MARKET HALL.



ROOF OVER ... FOR MARKET HALL



ROOF OF WORKSHOP — FOR RUSSIAN GOVERMENT.



THE ARTIZAN.

No. 237.—Vol. 20.—SEPTEMBER 1, 1862.

L. SCHWARTZKOPFF'S PATENT STEAM HAMMER.

(*Illustrated by Plate No.* 220.)

We have much pleasure in drawing the attention of our readers to a novel contrivance in connection with steam hammers, introduced by Herr L. Schwartzkopff, a mechanical engineer at Berlin.

The distinguishing features of Herr Schwartzkopff's invention (illustrated by plate 220), consist in the peculiar construction of the moving parts of the hammer itself, by which the great speed of from 400 to 800 strokes (according to the pressure of steam) is obtained per minute; and the arrangement of the anvil block which is moveable by means of hydraulic pressure, and balanced by a counterweight which is always in free communication with the anvil block itself. Our plate illustrates a specimen of this hammer, exhibited by the inventor at the International Exhibition (Zollverein department, Western Annexe, No. 1282), where it can now be daily seen at work.

Amongst the advantages stated to be derivable from the application of the hydraulic anvil, may be mentioned the following, viz.:—the facilities afforded for modifying the blows given to the material under operation; the piston moving at an equal distance for each blow; the material worked upon is either removed from, or brought nearer to the tool holder or piston, by lowering or raising the block or anvil, and consequently the effect of the tool can be modified at the discretion of the workman, The anvil may also be lowered so that the tool does not touch the material under operation, the hammer being at the same time kept in motion without interruption. The anvil also, by transmitting the shock arising at each blow over the whole of the machine, completely absorbs the vibrations, and thus renders unnecessary the strong foundations required for the usual description of steam hammers. The material under operation is not merely worked upon superficially, but, through the elasticity of the anvil, the pressure is transmitted throughout the entire mass, and a greater uniformity in the density is obtained, thus rendering this construction of steam hammer especially adapted for hammering out metals into sheets or plates. The counterweight, besides keeping the anvil block steadily on the same spot, renders unnecessary any addition to, or diminution of, the quantity of liquid, no fresh supply being requisite (except only to make good the loss from evaporation), for raising or lowering the anvil block; it also aids in distributing the shocks of the blows communicated to itself from below, throughout the whole of the framework.

The hammer is double-acting.—In our illustration, plate 220, A is the standard or main frame, being a ribbed girder bolted on the anvil-bed, B; C is the block which supports the steam cylinder and the entire moving mechanism. The steam enters from the steam pipe *a* into the slide valve chest *b*, enclosing the slide valve *c*, which is constructed on the equilibrium or balanced principle for obtaining rapidity of motion, combined with as little friction as possible. *d* is the steam cylinder, bolted on the block C; in this cylinder moves up and down the piston, fixed on the cast-steel piston rod *e*, which is made of a large diameter, in order to obtain the required weight and strength, and is guided in a slot at the lower extremity of the block C. The cross-head *f*, being fastened to the piston rod, slides on one side in a groove on the block C, for preventing the piston from turning, and thus disturbing the operation of the hammer; the crosshead carries on a bolt or stud, attached to itself, the friction roller *g*; this friction roller, by acting on the inclines or tappets *h*, produces the up and down motion of the slide valve at each successive stroke of the piston, according to the shape of the incline, by means of a small lever and the slide rod *i*. To the lower end of the piston rod is fastened the hammer head or tool *k*, adapted for the special purpose in view; *r* is the anvil block.

The anvil bed B contains two hydraulic cylinders *l* and *m*, filled with water, oil, or any other suitable liquid; the cylinder *l* is furnished with the anvil or ram *n*, working through a leather collar *x*, or any other packing, and bearing the anvil block *r*; *q* is a stud, furnished with a key for preventing the turning of the ram during the operation. The other hydraulic cylinder *m* contains the solid cylinder *o*, being of the same weight as the ram *n*, and working through a similar packing. The two hydraulic cylinders communicate with each other by means of a pipe or channel *p*, cast with the anvil bed, joining the two hydraulic cylinders, and allowing a free communication of the liquid from one to the other; by this means the two rams *n* and *o* balance each other. The position of the ram *o*, and consequently of *n*, and the anvil block *r*, can be altered by means of the lever handle *u*, sliding on a quadrant or sector *t*, and adjustable on the latter at any required distance by an adjusting screw or break lever *s*. For very large hammers a fly wheel and toothed rod, a screw or any other similar contrivance may be substituted for this latter mechanism.

The two solid rams balancing each other, the operative has only to overcome the friction in raising or lowering the anvil, and thus the workman is able, easily and readily, to regulate the effect of the blows of the hammer on the material under operation.

USEFUL NOTES AND FORMULÆ FOR ENGINEERS.

(*Continued from page* 173.)

On the Strength of Wrought Iron Tubes to Resist External Pressure.

There was a great want of information on this point until Mr. W. Fairbairn recently undertook a series of experiments for the purpose of determining the laws which regulate the resistance to collapse. The results of these experiments, which were performed upon wrought iron rivetted tubes, varying from 1·5 feet to 10 feet in length, were as follows:—

Let P' = collapsing pressure in lbs.
P = collapsing pressure per square inch.
R = resistance of material to compression or buckling.
L = length of tube in feet.
D = diameter of tube in inches.
k = the thickness of plates in inches.
$p = P L D$.

C a constants to be determined from data supplied by the experiments.

Since P' varies as the longitudinal section of the tube we have

$$P' = C' P L D$$

the resistance of thin plates to crumpling has been determined by experiment, to vary as a power of the thickness the index of that power lying between 2 and 3, hence we assume

$$R = C'' k^a$$

but when rupture occurs $P' = R$ and

$$C' P L D = C'' k^a$$

$$\therefore P = \frac{C k^a}{L D} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

For tubes of the same thickness we obtain the equality

$$P L D = P_1 L_1 D_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

To determine the values of a and C we have

$$\frac{P L B}{P_1 L_1 D_1} = \left(\frac{k}{k_1}\right)^a$$

Putting p for P L D we have

$$\frac{p}{p_1} = \left(\frac{k}{k_1}\right)^a$$

which enables us to embrace a range of experiments from which to take a mean

$$\therefore a = \frac{\log. p - \log. p^1}{\log. k - \log. k_1} \quad . \quad . \quad . \quad (3)$$

and similarly we find

$$C = \frac{p}{k^a} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The results of the experiments show that for tubes with plates of the same thickness the strength varies as the longitudinal section, so that p is nearly constant.

The mean value of P obtained from experiments on three tubes, each ·043 inches thick

$$= \frac{170 + 137 + 140}{3} = 149$$

from experiments on three other tubes the same thickness

$$= \frac{48 + 52 + 65}{3} = 55$$

The mean value of p from

8 Experiments on	4 inch tubes	= 891·6
4 „	6 „	= 884·5
3 „	8 „	= 812·8
2 „	10 „	= 845·5
3 „	12 „	= 688·0
	General mean	824·0

The large tubes show a rather low value for p, probably caused by the difficulty of maintaining such tubes cylindrical. From this it appears that a correction depending on the ratio of the diameter of the tube to its thickness may be requisite to render formula

$$P = \frac{C k^a}{L D}$$

mathematically correct, this correction having the form

$$- E \times \frac{D}{k}$$

where the constant E is to be determined by experiment.

To find the value of C and a. In equation (3) taking

$$p = 40{,}030 \text{ when } k = \cdot 25$$
$$p_1 = 820 \quad „ \quad k_1 = \cdot 043$$

$$a = \frac{\log. 40{,}030 - \log. 820}{\log. \cdot 25 - \log. \cdot 043} = 2\cdot 23$$

Similarly with other cases,

$$a = \frac{\log. 40{,}030 - \log. 9140}{\log. \cdot 25 - \log. \cdot 125} = 2\cdot 14$$

and again,

$$a = \frac{\log. 10{,}495 - \log. 820}{\log. \cdot 14 - \log. \cdot 043} = 2\cdot 16$$

and taking the mean of these values $a = 2\cdot 19$.

For the value of C we have from (4)

$$C = \frac{p}{k^a} = \frac{820}{\cdot 043^{2\cdot 19}} = 806{,}300$$

substituting these values we get from (1)

$$P = 806{,}300 \times \frac{k^{2\cdot 19}}{L D}$$

which is the general formula for calculating the strength of wrought iron tubes to resist external pressure.

It may also be written

$$\text{Log. } P = 1\cdot 5265 + 2\cdot 19 \log. 100\, k - \log. (L D)$$

We may approximate to the strength of elliptical tubes by making D in the above formulæ equal to the diameter of the circle of curvature touching the extremity of the minor axis. It is not desirable to have flues longer than ten feet, and long flues may be divided into ten feet lengths by stout rings of angle iron fixed within them.

Resistance to Shearing.

In this article we shall only consider the case where the shearing strain is equally distributed, to insure which the rivet or other fastening must be firmly fixed in its socket.

Then if S = the shearing force.
A = the area of the rivet.

the intensity of the force per unit

$$= \frac{S}{A}$$

For the economical distribution of material in rivetted work, the resistance to tearing should equal the resistance to shearing; or if

T = tensile strength per square inch of principal pieces,
A = sectional area of ditto,
S = resistance to shearing of a square inch of fastening material,
a = sectional area of ditto,

the strength should be

$$T A = S a; \text{ or, } \frac{T}{S} = \frac{a}{A}$$

For wrought iron rivetted plates we find from experiment

$$\frac{T}{S} = 1 \text{ nearly } \therefore A = a$$

For wrought iron bars, connected by bolts or rivets,

$$\frac{T}{S} = \frac{6}{5} \text{ nearly } \therefore \frac{6}{5} A = a$$

Examples:—

(1) Overlapped single rivetted joint,

t = thickness of plate,
d = diameter of rivet,
c = distance from centre to centre of rivets.

then
$$1 = \frac{S}{T} = \frac{0\cdot 7854\, d^2}{t\,(c - d)}$$

and
$$c = \frac{0\cdot 7854\, d^2}{t} + d$$

In practice d is usually from $2\,t$ to $1\frac{1}{2}\,t$, and the overlap from c to $1\frac{1}{10}\,c$.

(2) Overlapped double rivetted joint,

$$1 = \frac{S}{T} = \frac{1\cdot 5708\, d^2}{t\,(c - d)}$$

$$\therefore c = \frac{1\cdot 5708\, d^2}{t} + d$$

Overlap in practice $1\frac{3}{5}\,c$ to $1\frac{3}{4}\,c$.

(3) Butt joint with a pair of single rivetted cover plates. Here each rivet can give way only by being sheared across in two places at once; therefore,

$$1 = \frac{S}{T}\ \frac{1\cdot 5708\, d^2}{t\,(c - d)} \quad \therefore c = \frac{1\cdot 5708\, d^2}{t} + d$$

Length of each covering plate is in practice twice the overlap, the latter being from $2\,c$ to $2\frac{1}{5}\,c$.

(4) Butt joint with a pair of double rivetted cover plates.

$$1 = \frac{S}{T} = \frac{3\cdot 1416\, d^2}{t\,(c - d)}$$

$$\therefore c = \frac{3\cdot 1416\, d^2}{t} + d$$

Length of each covering plate is twice the overlap, the latter being from $3\frac{1}{3}\,c$ to $3\frac{1}{2}\,c$.

The length of a rivet before clenching is about $4\frac{1}{2}\ t$ for overlap, and $5\frac{1}{2}\ t$ for butt joints.

From some experiments upon the resistance of tubes to internal pressure, rivetted according to the practice of boiler makers, Fairbairn concluded the strength of the joints to be, if

Strength of plate = 100

then Strength of single rivetted joint = 56

Strength of double rivetted joint = 70.

RESISTANCE TO TORSION.

The moment of torsion is the moment of a pair of equal and opposite forces applied to two cross sections of the bar, in planes perpendicular to the axis, tending to make the portion of the bar between those sections rotate in opposite directions about the axis.

Let A B (fig. 27) be a cylindrical axle subject to the pair of twisting forces A B. It is required to find the condition of strain at any cross section C, and the angular displacement of any cross section relatively to any other.

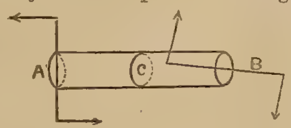


FIG. 27.

From the uniformity of the bar and of the twisting moment it is evident that the condition of strain is the same for all cross sections, also because of the circular figure of the bar the condition of strain for all particles equidistant from the axis must be alike.

Suppose a circular layer to be included between c and another cross section at a distance $d\,x$ from it.

The twisting moment causes one of those cross sections to rotate about the axis of the cylinder through an angle which may be called a. Then, if there be two points at the same distance r from the axis, one in the one cross section, and one in the other, originally opposite to each other in a line parallel to the axis, the twisting moment shifts one of these points laterally with regard to the other through the distance $r d\,a$. Consequently the part of the layer which lies between those points is distorted, in a plane perpendicular to the radius, and the distortion is expressed by

$$y = r\,\frac{d\,a}{d\,x} \quad \ldots\ldots\ldots \quad (1)$$

which varies in proportion to the distance from the axis.

There is therefore a shearing stress at each point of the cross section c whose direction is perpendicular to the radius drawn from the axis to that point, and whose intensity is proportional to that radius, being represented by

$$q = C\,y = C\,r\,\frac{d\,a}{d\,x} \quad \ldots \quad (2)$$

The strength of the axle is determined in the following manner :—

Let S = limit of shearing strain to which the material is to be subject,
r_1 = the external radius,
ρ = any other radius,

then S is the value of q for a fibre at the distance r from the axis, at any other distance

$$q = \frac{S\,\rho}{r} \quad \ldots\ldots\ldots \quad (3)$$

Conceive the cross section to be divided into narrow concentric rings, the breadth of each being $d\,\rho$, then let ρ be the mean radius of one of these rings.

Then its area

$$= 2\,\pi\,\rho\,d\,\rho$$

the shearing stress on it is given by formula (3), and the leverage of that stress is ρ, therefore the moment of shearing stress on that ring

$$= \frac{2\,\pi\,S}{\rho}\,\rho^3\,d\,\rho \quad \ldots\ldots \quad (4)$$

which being integrated for all rings from the circumference to the centre gives for the moment of torsion

$$M = \frac{2\,\pi\,S}{r}\int_o^r \rho^3\,d\,\rho = \frac{\pi\,S\,r^3}{2}$$

$$\left(\frac{\pi}{2} = 1{\cdot}5708\right)$$

If the axle is hollow, r_1 being the interior radius,

$$M = \frac{2\,\pi\,S}{r}\int_{r_1}^r \rho^3\,d\,\rho = \frac{\pi\,S\,(r^4 - r_1^4)}{2\,r} \quad \ldots \quad (5)$$

Let d be the external diameter, and d_1 the internal diameter of the axle, then

For a solid axle . . . $M = \frac{\pi\,S\,d^3}{16} = \frac{S\,d^3}{5{\cdot}1}$

For a hollow axle . . . $M = \frac{S\,(d^4 - d_1^4)}{5{\cdot}1\,d}$

ANGLE OF TORSION.

We now proceed to find the angle made by two diameters originally parallel; this is obtained by means of equation (2), which gives for the angle of torsion per unit of length

$$\frac{d\,a}{d\,x} = \frac{q}{C\,r}$$

the condition of the axle being uniform at all points the above quantity is constant.

If x = length of axle,
a = angle of torsion, expressed in length of arc to radius 1,

$$\frac{d}{x} = \frac{d\,a}{d\,x} \quad \therefore\ a = \frac{x\,q}{c\,r}$$

CO-EFFICIENTS OF STRESS.

The co-efficients of stress for any material is that stress which may be continually applied without danger of injuring the strength of the material; it is here stated for a square inch of sectional area.

When the elasticity of any material is impaired a permanent set is produced, and the strength of that material reduced; therefore the strain to which structures are subject should not approach the limit of elasticity.

Some experiments on good bar iron showed that the elasticity began to be unimpaired at about 13 tons tension per square inch. Most of our formulæ for the strength of materials have reference to a load at rest, but structures are frequently exposed to loads in motion which produce a much greater strain on the material, if their velocity is considerable, it is therefore necessary to allow an excess of strength.

For structures consisting of pieces incapable of moving, as bridges, columns, &c., the following co-efficients may be safely applied.

Safe Stress per square inch of Sectional Area.

	Tension.	Compression.
Wrought Iron	4·5	3·5
Cast Iron	1·75	3·75

The co-efficient for the shearing stress on wrought iron is about 4·5 tons per square inch bar iron in all cases opposing more resistance to rupture than plate iron.

In machinery much greater strength is required for the various parts than the above co-efficients would give, thus for the main shafts of prime movers, &c., we have the following data from actual practice :—

A steam engine of 40 horse-power, moving at the speed of 25 revolutions per minute, required a shaft 8 inches in diameter to work safely.

We will deduce the value of $s\,p$ from these data.

One horse-power is represented by 33,000 lb raised one foot per minute; therefore in the above case the engine did work equal to 33,000 lb raised 40 feet in 25 revolutions, or 1320 lb raised 40 feet in one revolution, the moment of which will be equal

$$1320 \times \frac{40}{2\,\pi},$$

or, 1320 acting with a leverage equal to the radius which corresponds to a circumference of 40 feet, but by

$$\frac{\pi\,s\,r^3}{2} = \text{moment of torsion.}$$

$$\therefore\ 1320 \times \frac{40}{2\,\pi} = \frac{\pi\,s\,r^3}{2}$$

$$52{,}800 = \pi^2\,s\,r^3$$

$$\pi = 3{\cdot}1416,\ \pi^2 = 9{\cdot}87$$

$$r = 4\text{ ins. } r^3 = 64\text{ ins.} = 5{\cdot}33\text{ ft.}$$

$$\therefore\ \frac{52{,}800}{52{\cdot}64} = S = 10{\cdot}031\text{b.}$$

the practical rule for the size of the main shaft of prime movers will be

if r = radius of shaft.
P = horse-power of engine.
R = number of revolutions of main shaft per minute.

$$r = \sqrt[3]{\frac{40\,P}{R}}$$

ABSTRACT OF ENGINEER'S LOG OF THE "GREAT EASTERN." FIFTH VOYAGE FROM LIVERPOOL TO NEW YORK, JULY, 1862.

Date each day, ending at Noon.	Paddle Engines: Revolutions of Engines each day.	Paddle Engines: Average Revolutions per minute.	Paddle Engines: Average Pressure of Stm. in Engine-room.	Paddle Engines: Tons of Coal used each day.	Screw Engines: Revolutions of Engines each day.	Screw Engines: Average Revolutions per minute.	Screw Engines: Average Pressure of Stm. in Engine-room.	Screw Engines: Tons of Coal used each day.	Total quantity of Coal used each day.	Number of Knots run by Paddle Engines.	Number of Knots run by Screw Engines.	Distance run by Ship in Knots.	Latitude.	Longitude.	Course.	Barometer.	Observations on Rolling of Ship: Inclination to windw.	Observations on Rolling of Ship: Inclination to leeward	Observations on Rolling of Ship: No. of oscil. per min.	General Remarks.
			lbs.	Tons			lbs.	Tons	Tons	K.	K.	K.				inches.	deg.	deg.		
July 1 ...	134	...	...	...	2,550	...	...	...	...	...	...	...	...	...	...	...	...	...	...	At 11.35 A.M. started engines ahead slow.
July 2 ...	11,543	10·4	23	127	40,550	36·2	17½	133	260	273	276	230	Steering by the land.			...	...	...	...	At 1.25 P.M. full speed.
July 3 ...	10,940	10·4	23	124	38,350	36·2	17	155	279	273	276	234	51·6 N.	14·5 W.	W. ¼ S.	30·10	0	0	0	At 8.50 A.M. arrived off Queenstown Harbour.
July 4 ...	15,386	10·5	22	134	52,100	36·2	17	157	290	382	387	345	56·50 N.	22·34 W.	W.	30·00	2	4	5	At 7.35 P.M. started engines a-head full speed.
July 5 ...	15,391	10·45	22	134	52,650	36·0	17	158	292	382	387	330	50·6 N.	30·43 W.	W. ½ S.	30·20	4	7	6	Light beam wind; fore and aft sails set.
July 6 ...	14,654	10·0	21½	127	52,270	35·3	17	157	284	367	381	315	49·23 N.	38·19 W.	W. ¾ S.	29·70	6	9	5½	Strong S.W. gale.
July 7 ...	15,626	10·64	22	130	51,730	36·0	17	158	288	385	383	305	48 1 N.	45·34 W.	W. ¾ S.	29·78	1	2	3	Strong head wind; passed several icebergs.
July 8 ...	16,643	11·3	22	134	53,760	36·7	17	164	298	410	396	290	46·34 N.	52·30 W.	W. by S. ½ S.	30·00	2	3	5	At 8.55 A.M. stopped engines and reversed to clear floating ice.
July 9 ...	16,435	11·3	22	134	51,890	36·0	17	164	298	410	383	325	44·20 N.	59·53 W.	W. S. W.	30·00	1	2	3	At 12.30 P.M. stopped engines off Cape Race.
July 10 ...	17,024	11·6	20½	134	52,790	36·0	17½	164	298	417	381	320	41·42 N.	66·13 W.	W. S. W.	30·03	2	2	3	Dense fog; standing by engines.
July 11 ...	16,718	11·4	20	132	51,660	36·0	17½	161	296	416	380	305	41·10 N.	72·52 W.	Various.	30·35	0	0	0	At 8.30 A.M. stopped engines to take pilot on board off Montack Point, all particslars of engines taken up till time, afterwards steamed easy to our mooring and dropped anchor at 4 P.M.
July 12 ...	2,689	...	19	18	7,930	...	17½	25	43	67	60	60	...	...	...	...	...	...	...	
Total	153,186	11·25	22	1327	508,230	37·3	17¼	1599	2926	3782	3690	3059	...	...	...	...	...	...	...	

Time steaming from Liverpool to Queenstown, 17 h. 25 min.; Queenstown to Montak Point, 8 days 17 h. 35 min. Actual time steaming Liverpool to New York, 9 days 11 hours.

Density of water in boilers, 1⅝; vacuum in paddle engines, 25; vacuum in screw engines, 25; extreme diameter of paddle wheel, 50ft.; effective diameter 48ft. = 150·79ft. each revolution; pitch of screw, 44ft.; knots run per hour, 13·48; immersion on leaving Liverpool, 23ft. 6in. forward, aft. 23ft.; immersion on arrival at New York 20ft. 9in. forward; aft, 25ft. 4in.; slip of paddle wheels, 19 per cent.; average daily consumption of coals by paddle engines, 139 tons; ditto by screw engines, 168 tons; total daily consumption, 308 tons.

(Signed) J. RORISON, Chief Engineer.

ABSTRACT OF ENGINEER'S LOG OF THE "GREAT EASTERN." FIFTH VOYAGE FROM NEW YORK TO LIVERPOOL, JULY AND AUGUST, 1862.

Date each day, ending at Noon.	Paddle Engines: Revolutions of Engines each day.	Paddle Engines: Average Revolutions per minute.	Paddle Engines: Average Pressure of Stm. in Engine-room.	Paddle Engines: Tons of Coal used each day.	Screw Engines: Revolutions of Engines each day.	Screw Engines: Average Revolutions per minute.	Screw Engines: Average Pressure of Stm. in Engine-room.	Screw Engines: Tons of Coal used each day.	Total quantity of Coal used each day.	Number of Knots run by Paddle Engines.	Number of Knots run by Screw Engines.	Distance run by Ship in Knots.	Latitude.	Longitude.	Course.	Barometer.	Observations on Rolling of Ship: Inclination to windw.	Observations on Rolling of Ship: Inclination to leeward	Observations on Rolling of Ship: No. of oscil. per min.	General Remarks.
			lbs.	Tons			lbs.	Tons	Tons	K.	K.	K.				inches.	deg.	deg.		
July 26 ...	...	...	...	20	...	...	...	38	58	...	...	...	...	...	...	...	...	...	...	At 4 P.M. started paddle and screw engines a-head full speed. At 11.30 P.M. stopped engines to discharged pilot off Montank Point.
July 27 ...	11,191	...	23·0	113	38,270	...	16½	143	256	243	259	220	43·07 N.	63·31 W.	Various.	...	0	0	0	At 11.40 P.M. started engines a-head full speed.
July 28 ...	13,201	9·4	23·0	126	48,880	34·6	16½	149	275	331	349	308	43·07 N.	63·31 W.	N.E. by E. ½ E.	...	6	8	5	Light head wind; sea smooth.
July 29 ...	13,909	9·9	23·0	129	50,520	35·6	17½	154	283	347	367	304	45·31 N.	57·40 W.	N.E. by E. ¼ E.	30·35	4	5	5	Light head wind; coals running very small for screw boilers.
July 30 ...	12,506	9·0	22·0	129	49,220	35·0	17½	149	278	321	359	333	46·53 N.	49·57 W.	E. by N. ¾ N.	30·58	2	3	5½	At 3.25 A.M. stopped engines off Cape Race. At 4.45 full speed.
July 31 ...	11,041	10·0	22·0	129	50,630	36·0	17½	155	284	352	370	286	47·58 N.	43·51 W.	E. by N. ¼ N.	30·64	2	3	5	Light beam wind; fore and aft sails set.
Aug. 1 ...	14,239	10·12	22·0	138	50,150	35·0	17½	161	299	350	359	306	49·29 N.	36·28 W.	E.N.E.	30·50	2	3	5	Light beam wind; fore and aft sails set.
Aug. 2 ...	14,326	10·11	21·0	138	49,430	35·0	17½	162	300	352	361	326	50·58 N.	28·10 W.	E. by N. ½ N.	30·00	3	4½	5	Light fair wind; square sails set.
Aug. 3 ...	13,909	10·0	20·0	138	47,870	34·3	16½	160	298	347	347	310	51·10 N.	20·37 W.	E. by N.	29·80	6	8	5	Light fair wind; square sails set.
Aug. 4 ...	13,058	9·3	15½	138	44,640	33·0	15½	160	298	330	340	305	51·22 N.	13·01 W.	E.	29·70	7	8	4½	Light fair wind; square sails set.
Aug. 5 ...	13,000	9·32	15½	138	46,340	33·22	16½	160	298	327	335	280	......Steering by the land			29·60	7	8½	5	Light fair wind; fore and aft and square sails set.
Aug. 6 ...	5,845	9·7	16	57	22,235	36·0	17½	67	124	178	187	145				...	2	1	4	At 6.55 P.M. stopped engines to take pilot on board. At 10 P.M. stopped paddle engines; waiting for tide. Screw engines working easy all night.
Total	139,228	9·7	21½	1393	498,185	35·0	17	1658	3051	3478	3663	3128	...	...	...	...	...	...	...	

Actual time steaming from New York to Liverpool, 10 days 30 minutes.

Indicated horse-power of paddle engines, ——; indicated horse-power of screw engines, ——; density of water in boilers 1⅝; vacuum in paddle engines, 24; vacuum in screw engines, 25; extreme diameter of paddle wheels, 50ft.; effective diameter 48ft. = 150·79ft. each revolution; pitch of screw, 44ft.; knots run per hour, 13·01; immersion on leaving New York 26ft. 3in. forward, 29ft. 9in. aft.; immersion on arrival at Liverpool, 24ft. 6in. forward, 25ft. 6in. aft.; slip of paddle wheels 11·2 per cent.; slip of screw, 17 per cent.; average daily consumption of coal by paddle engines, 139 tons; ditto by screw engines, 165 tons; total daily consumption, 304 tons.

(Signed) J. RORISON, Chief Engineer.

DR. GRIMALDI'S ROTATORY STEAM BOILER.

The idea on which Dr. Grimaldi's invention is based is that of causing the boiler to revolve slowly in the furnace,—being driven by a pulley or any other contrivance in connection with the motor. From this combination the following advantages are stated to be derived:—it facilitates getting up the steam vere quickly, through the agitation caused in the water by the continual revolving of the boiler; the entire boiler is uniformly heated, the whole of its surface being successively used as heating surface, and hence a great economy of fuel is realized, and priming prevented.

The accompanying illustration shows a boiler of 22 N.H.P., constructed on Dr. Grimaldi's plan, and exhibited by the inventor at the International Exhibition, Italian Department, Western Annexe, No. 1001. Fig. 1, is a longitudinal section taken through the centre of the boiler; Fig. 2, a transverse section taken at M. M. From the fire-grate T, the fire passes over the surface of the boiler R, and through the interior of the four flue tubes o. o. The boiler is fitted with the fore and aft trunnions *s* and *u*, which turn in bearings; *q* is the feed-pipe, and *c* the steam-pipe. The feed-pipe is kept in its place by means of the cross and side bars *i* and *v*. The trunnion *u*, enclosing the combination of the feed-pipe *q*, is turned by a worm and screw or any other similar mechanism. The driving power required is very small, as the boiler makes but one revolution per minute; *a* is the water guage, which acts like a syphon, *c* is the steam guage, *Q* is the masonry, *t* the furnace, *l l* are two sets of bricks preventing the flames from over heating the top of the boiler when not in motion.

The chief dimensions and particulars of the boiler, exhibited by Dr. Grimaldi, are as under:—

Diameter of the boiler 4 ft., length 8ft. 6in., plate $\frac{7}{16}$.

Diameter of flues 1ft. 2in., plate $\frac{3}{8}$.

The boiler has been tested at a pressure of 200 pounds per square inch, and with safety stands a working pressure of 75 pounds per square inch.

This construction of boilers, unlike the Cornish ones, is adapted for the consumption of every kind of fuel, and is well suited for marine purposes.

We understand that a marine boiler of 25 N.H.P. of 7ft. 3in. length, by 4ft. diameter, fitted with 50 tubes of 3in. each, is now being executed for Dr. Grimaldi, and we have no doubt that a trial of it will soon enable us to bring before the knowledge of our readers the practical results to be obtained from this contrivance.

FIG.-2.

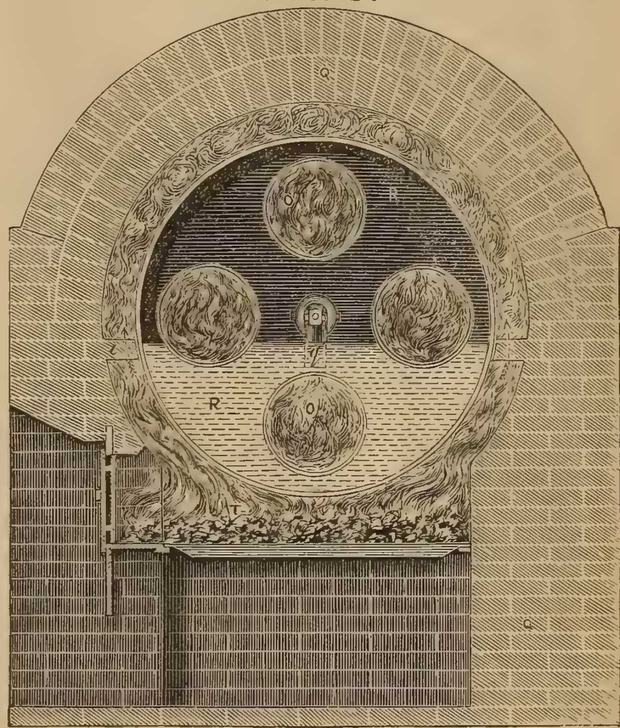
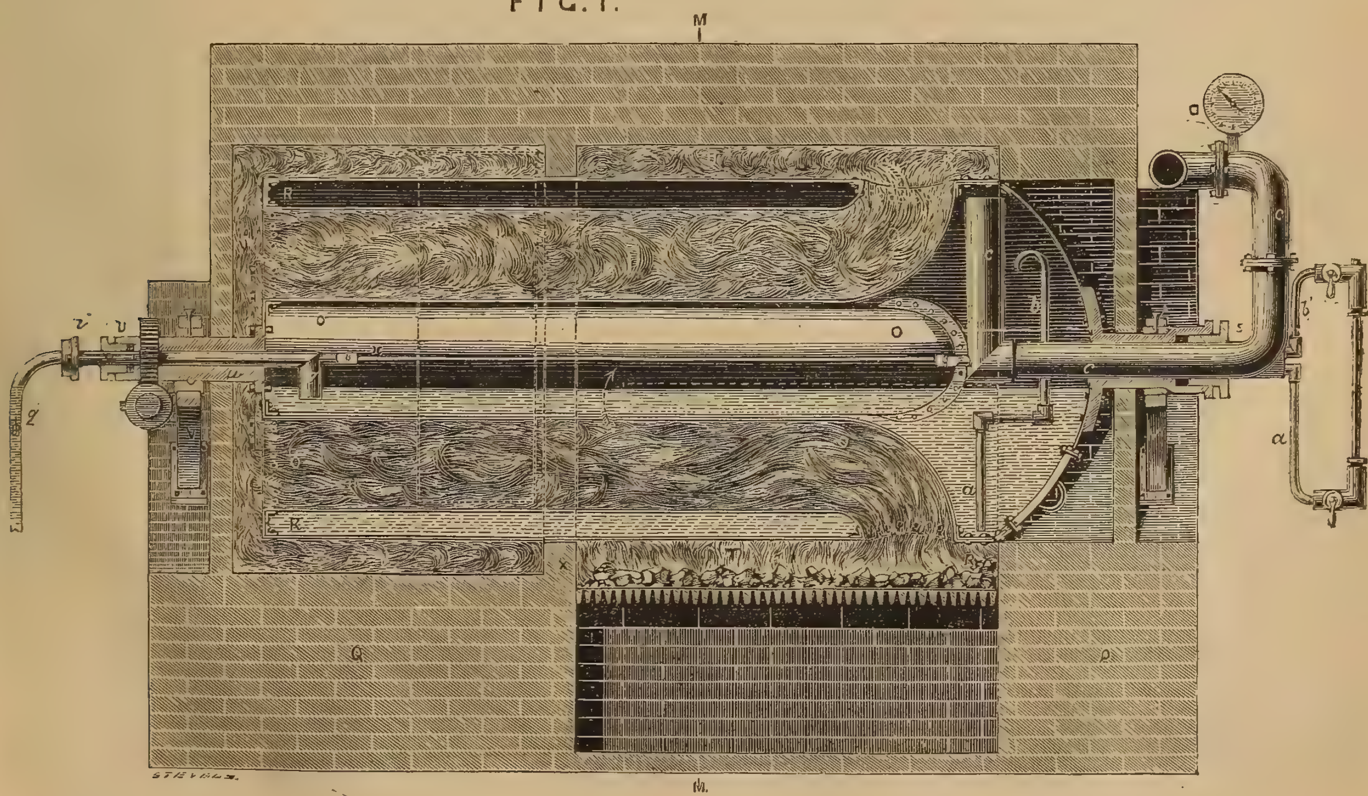


FIG. 1.



STRENGTH OF MATERIALS.

DEDUCED FROM THE LATEST EXPERIMENTS OF BARLOW, BUCHANAN, FAIRBAIRN, HODGKINSON, STEPHENSON, MAJOR WADE, U.S. ORDNANCE CORPS, AND OTHERS.

(*Continued from page* 176.)

Effect of Impact on Cast and Wrought Iron.

Horizontal and Vertical.—The power of a bar, beam, &c., to resist impact varies with the mass of the bar, &c., the striking body being the same, and by increasing the inertia of the bar, &c., without adding to its strength, the power to resist impact is, within certain limits, also increased.

Hence, weight is an important element in structures exposed to concussion.

If blows of equal magnitude are given upon the middle of a bar, beam, &c., either by elastic or inelastic bodies of the same weight, the same effect will be produced.

The *resilience*, or power of springing back of a bar, beam, &c., resisting at ransverse impulse, follows a law very different from that determining its transverse strength, as it is simply proportional to the bulk or weight of the bar, &c., without any reference to the form of the section of it, or whether it is solid or hollow.

Thus, a bar, &c., 10ft. in length will support but half the load without breaking that one of the same breadth and depth which is 5ft. in length; but it will bear the impulse of a double weight striking against it with a given velocity, and will require a given body should have a double momentum to break it.

The ultimate deflections of bars of different sections, struck with like weights and velocities of them, will differ in the proportion of the product of the squares of the section in the direction of the impact and the dimension of the section perpendicular thereto.

The ultimate breaking deflection of bars, &c., of like dimensions of section compared with others having twice the length between their supports, is somewhat greater than one-fourth, and the vertical* distance fallen through by the body of impact, to produce fracture is somewhat more than one-half.

Hence, the depth fallen through to break the bar of half the length, is nearly half of that required to break the bar of whole length.

When bars, &c., are struck in the middle between the centre and one support, the chords of impact necessary to produce fracture are nearly equal in both cases and the ratio of the deflections from equal impacts are nearly constant under different increasing degrees of impact; the deflections from the centre between the supports from equal impacts, being to those at one-fourth the distance as 10 to 7 nearly.

With bars, &c., of like dimensions and distance between their supports, struck with balls of different weights, the ultimate deflection is very nearly equal, but the vertical descent of the ball is very nearly in the inverse ratio of the square of the weight.

In cast-iron bars, &c., the deflections are greater than, in proportion to the velocity of impact; whilst in wrought-iron they are very nearly constant with impacts of different velocities.

Bars, &c., when uniformly loaded, resisted greater impacts from like weights than when unloaded; in same proportion of loading, the resistances were as 2 to 1.

Table of the Results of Experiments on the Continued Impact of Cast and Wrought Iron Bars.—(Rep. of Com. on Railway Structures.)

Impact and Material.	Distance between the supports.	Weight of striking ball.	Radius of arc of oscillation of ball.	Dimensions of Bar.		Weight of bar between supports.	Ultimate deflection.	Set.	Chord of arc of impact.	Height fallen through by ball at each blow.	Velocity of impact of ball per second.	Ultimate work done by the ball.	Breaking weight of like bar by vertical transverse pressure.	Ultimate deflection by breaking vertical pressure.
				In deflection of impact.	Perpendicular to impact.									
	feet.	lbs.	feet.	inches.	inches.	lbs.	inches.	ins.	ins.	feet.	feet.	lbs.	lbs.	ins.
Horizontal.—Cast Iron	13·5	603	17·5	3·046	3·036	378	4·875	·783	79·	1·238	8·925	747	3000	4·55
" "	13·5	603	17·5	1·53	6·122	381	9.	1·320	78·	1·207	8·812	728	1500	—
" "	13·5	603	17·5	6·095	1·538	384	2·4	2·635	80·	1·270	9·038	766	6000	—
" "	6·75	603	17·5	3·	3·	193	1·23	·164	56·75	·639	6·411	385	6000	1·272
" "	9·	151·3	17·5	2·012	1·983	108	2·75	·296	80·5	1·286	9·094	194	750	—
" "	9·	75·5	17·5	1·974	2·001	106	2·83	·320	124·	3·051	14·008	230	750	—
" Wrought Iron ...	4·5	75·5	17·5	2·	2·	54	·892	·131	98·5	1·925	11·128	145	1500	—
" " ...	13·5	151·3	17·5	1·515	5·523	372	3·	·040	119·8	2·845	13·528	430	...	—
" " ...	13·5	603	17·5	1·515	5·523	372	4·	...	61·18	·743	6·913	448	...	—
" " ...	13·5	303	...	1·522	5·018	338	5·182	3·82	...	3·	13·892	909	...	—
Vertical.—Cast Iron............	13·5	303	...	3·	3·	382	3·745†	...	...	2·625	12·995	795	3000	4·55
" "	13·5	303	...	3·	3·	779*	3·786†	...	...	3·5	15·005	1060	3000	4·55
" "	13·5	303	...	3·	3·	1343*	3·338†	...	...	4·5	17·015	1363	3000	4·55

* Loaded uniformly with additional weight.
† Broke at impacts due to a height of 33, 45, and 60 feet respectively.

From a number of experiments on the impact of cast-iron bars, it appeared that but a very few of them withstood 4000 blows, each deflecting them through half of their ultimate deflection; but all the bars when sound withstood this number of blows, each deflecting them through one-half of their ultimate deflection.

Bars, beams, &c., are subjected to a regular depression equal to the deflection due to a load of one-third of their statical breaking weight, will bear 10,000 successive depressions, and when broken by statical weights will bear as grear a resistance as like bars subjected to a like deflection by statical weight.

To ascertain the weight of the body of impact that can be sustained by a Rectangular Bar, &c., of Cast Iron.

When the velocity of the body, the area and length of the bar, &c., are given.

Rule.—Divide the product of 45 times the length between the supports of the bar in feet by the area of the section in inches, by the square of the velocity of the body of impact in feet per second, and the quotient is the weight required;

or,
$$\frac{45\, l\, b\, d}{v^2} = W.$$

Example.—A beam of cast iron 13·5 ft. in length between its supports and 3 inches square is struck by a ball with a velocity of 10 feet per second; what is the weight of the ball?

$$\frac{45 \times 13{\cdot}5 \times 3 \times 3}{10^2} = \frac{5467{\cdot}5}{100} = 54{\cdot}675 \text{ lbs., the weight of the ball.}$$

When the height of the fall is given, proceed as when the velocity is given, substituting for it 64·3 time the height of the fall.

* The versed sine of the arc described by the oscillation, or swinging of a body of impact.

To ascertain the area of a Cast Iron Beam that can sustain a given impact.

When the velocity and weight of the body of impact and the length of the beam are given,

$$\frac{v^2 W}{45 l} = b d.$$

To ascertain the velocity of the body of impact that can be sustained by a Cast Iron Beam.

When the weight of the body, the length and area of the beam are given,

$$\frac{45 l b d}{W} = v^2.$$

To ascertain the weight of the body of impact on Cylinders, Grooved and Open Beams of Cast Iron.

Grooved beam. $\frac{45 l b d (1 - q p^3)}{v^2} = W.$

Open beam, $\frac{45 l b d (1 - p^3)}{v^2} = W.$

Rectangular ellipse, $\frac{58 l b d}{v^2} = W.$

Grooved ellipse, $\frac{58 l b d (1 - q p^3)}{v^2} = W.$

Open ellipse, $\frac{58 l b d (1 - p^3)}{v^2} = W.$

Results of Experiments to determine the Resistance of Cold and Hot Blast Irons to Vertical Impact.

The bars were of uniform dimensions, and were struck with a hammer when lying horizontally on supports.

Cold blast..................... 15 blows.
Hot blast .... 2 blows.

The power to resist impact, as determined by Mr. Fairbairn, upon a number of specimens of English, Welsh, and Scotch irons, 1 inch square and 4·5 feet between the supports, the highest in the order of their powers of resistance to transverse stress, was a mean of 817.

ON THE CONSTRUCTION OF IRON ROOFS.

By J. J. Birckel.

Illustrated by Plate No. 221.

(*Continued from page* 175.)

So far we have investigated the conditions of stability of those kinds of triangular roofs most generally adopted, and which we can best recommend to our readers. We purpose to treat of circular roofs in a separate paper, and have designedly omitted the consideration of them in the present investigation.

Having learned how to determine the relative amount of stress upon the various parts of a principal, we will now define the total amount of pressure which the roof, under certain circumstances, may have to resist. Among the accidental sources of pressure, those of wind and snow form the most important items, because both may occur simultaneously. According to General Morin's observations, snow may accumulate upon a roof to the depth of 20 inches, and as its weight is $\frac{1}{10}$th that of water, the pressure due to this element would be about 11lbs. per square foot; the same philosopher, however, thinks that one-half this amount will make ample provision; we will keep on the safe side, and suppose it to be 6lbs. per square foot.

Respecting the wind, we have subjoined a short table of the pressure produced at various speeds upon a plane of resistance supposed to be at right angles with the direction of the wind.

Speed in feet per second.	Pressure per sq. foot.	Speed in feet per second.	Pressure per sq. foot.
ft. in.	lbs.	ft. in.	lbs.
10 0	0·2	46 0	4·7
13 9	0·6	65 7	9·6
26 3	1·5	131 0	38·4
35 7	2·8		

General Morin, from whose work the above data are quoted, thinks that a direct pressure of 3lbs. per square foot is quite sufficient to reckon upon, but English engineers differ with him on that point, and make allowance for a pressure of 7 or 8lbs. per foot. As there is a great probability that there will be neither heavy rain nor hail while the maximum weight of snow rests on the roof, it may be assumed with safety that the two items of accidental pressure just defined will make sufficient provision for any other sources of accidental stress, of which, therefore, we need not take any special notice. In the following tables we give the items of permanent pressure due to the covering and to the structure of the roof itself, which, added to the items previously defined, will make up the whole weight, which must form the basis of calculation of the strength of the roof.

Table of Weight of Covering.

Nature of Covering.	Weight in lbs. per square foot.
	lbs.
Common Tiles	13
Hollow Tiles	16 to 19
Slates	8
Rolled Copper	3
Zinc..............................	2
Galvanized Sheet Iron ...	2
Corrugated Sheet Iron ...	$2\frac{1}{2}$
Asphalte......................	$5\frac{1}{4}$

Table of Weights of Principals and Purlins.

Distance of Principals.	Span.	Weight of Principal.	Weight of Purlins for one bay.	Weight per square foot of roofing.	OBSERVATIONS.
ft. in.	ft. in.	lbs.	lbs.	lbs.	
6 6	26 0	137	225	2·03	These data are quoted from GENERAL MORIN'S work; principals supposed to be trussed as per diagram No. 2; their weight in this table has been increased by the amount of one-fourth for deficiency in rafters; angle of roof about 25°.
6 6	40 0	337	290	2·20	
6 6	65 9	888	418	2·87	
6 6	82 0	1668	482	3·80	
9 10	26 0	194	508	2·59	
9 10	40 0	502	653	2·76	
9 10	65 9	1387	943	3·39	
9 10	82 0	2625	1088	4·34	
13 1	26 0	245	959	3·33	
13 1	40 0	580	1233	3·26	
13 1	65 9	1705	1781	3·81	
13 1	82 0	2755	2055	4·22	
Mean weight per square foot 3·22 lbs.					
9 0	84 0	4480	1980	7·10	Example No. 1 to be described.
14 0	54 0	2240	4935	8·83	" 2 "
6 6	55 6	2520	1681	10·0	" 3 "
6 0	26 0	600	330	5·34	" 4 "
20 0	72 0	3936	6116	4·77	" 5 "
Mean weight per square foot 7·2 lbs.					

From this it appears that General Morin's theoretical roofs are a little less than half as heavy as those selected from actual practice; but, as we have been very careful in our selection, we are inclined to think that the theoretical roofs are considerably too light.

If, now, we sum up the pressures arising from the various sources enumerated, we shall find that the loads per square foot for different kinds of covering are as follows:—

Nature of Covering.	Weight in lbs. per square foot.
	lbs.
Common Tiles	33
Hollow Tiles	39
Slates	28
Rolled Copper	23
Zinc..........................	22
Galvanized Sheet Iron ...	22
Corrugated Sheet Iron ...	$22\frac{1}{2}$
Asphalte.....................	$27\frac{1}{4}$

The load of 40lbs. per square foot, which is generally taken by English engineers as a basis in the calculation of roofs, is by no means exaggerated, though it may be quite sufficient. Having thus provided our readers with all the data required for the determination of the strength of the various parts of a roof, we will now proceed to the examination and description of the examples already referred to, and point out such practical details as may be of special interest in the study upon which we are engaged.

Example Fig. 1 is the roof over the Longton New Market, Staffordshire, and was designed by Mr. Burrell, the architect of that place. In this case the rafters are not allowed to meet at the apex of a triangle, but are connected by means of a collar some distance below that apex; the statical conditions of the trussing, however, are not changed on this account. The stresses upon the various parts of the principal are to be determined as if the rafters met at the apex, and the stress upon the collar is equal, and of contrary nature to that on the main tie, as due to the primary truss. To satisfy the minds of our readers, we have appended to the drawing of the roof the diagram of stresses. The rafters here are made of two angle irons, 3 in. × $1\frac{1}{2}$ in. × $\frac{1}{4}$ in., bolted back to back, having an aggregate area of $2\frac{1}{4}$ square inches, with a wooden packing between them, of adequate strength almost by itself to do the work of the rafter, if it were continuous; as it is, however, it forms no element of strength, and is only here for convenience of fixing the boarding which carries the slate. The thrust upon the rafter is $7\frac{3}{4}$ tons, and the stress upon the square inch, taking into account the bending moment, is about 8 tons. The tie rod is made of flat bars, and double, for convenience of making the joints; it has an area of 1.8 square inches, deduction being made for bolt holes, and, the maximum pull being 7 tons, sustains a stress of about 4 tons per square inch; in these respects, therefore, the roof is well proportioned. The secondary trussing, however, is defective, and as the bar C_3 A_3 instead of being a strong strut, is only a thin flat rod, the upper secondary truss can scarcely act as such, and, in consequence, a great stress is thrown upon the upper portion of the rafters. The collar supports a lantern roof, the vertical sides of which are glazed, the whole of the framing and sash bars being made of wood. As the principals are only 6 ft. 6 in. apart, there are no purlins to the roof, but a continuous layer of $1\frac{1}{4}$ in. boarding spans from principal to principal, and carries the slates. The proportion of wood in this roof is such as to lead us to suppose that it could never have been intended to be fire-proof, and on that ground we are inclined to ask the architect why he has introduced so much iron into it, and thrown so much more expense upon the purse of the market commissioners? or else to ask this latter respectable body why they did not grant the architect funds sufficient to enable him to realise the above-named most desirable object?

Example Fig. 6 is a roof and shed for the Russian Admiralty, and was, in the first instance, designed with an intended space of 10 feet between the principals. At the express desire of the Russian officials, however, this distance has been increased to 20 feet, although by so doing the weight of the whole structure has been somewhat increased also. The whole width of the space roofed over is 72 feet, but the actual span of the principal is only 52 feet, there being a space of 10 feet on each side, covered with a lean-to roof, glazed in the whole of its length, and so placed as to be continuous with the main rafter. This arrangement has been adopted in imitation of some of the sheds at Chatham Dockyard, for convenience of carrying a line of shafting on the main standard. The roof is very high pitched, being at an angle of 45°, on account of the heavy falls of snow experienced in the Russian climate; a louvre roof at a smaller angle of 30° spans about $\frac{1}{4}$th the whole roof, the vertical sides of which are glazed to admit the light into the centre of the building, and in order to prevent any great accumulation of snow upon it, a small platform has been provided upon the ridge to admit of a man walking along and pushing the snow down when that is required. The whole of the shed, with the exception of the glazed portions, is covered and enclosed with corrugated galvanized iron, No. 20 W. G. This circumstance has enabled the constructors of the roof, without incurring any additional expense, to place the purlins immediately over the centres of resistance of the trussing, and thus the rafters are relieved from all bending stress. The thrust upon them is $25\frac{1}{2}$ tons, to resist which we have an area of $4\frac{1}{2}$ square inches, causing a stress of $5\frac{3}{4}$ tons on the square inch. The main tie rods and braces are made of flat bar iron for the sake of cheapness and expedition in the execution of the work; the lower ties are made of two bars, $3\frac{1}{2}$ in. × $\frac{7}{16}$ in., and deduction being made in the area for bolt holes, sustain a stress of $8\frac{1}{2}$ tons to the square inch; the braces are made of a single bar $3\frac{3}{4}$ in. × $\frac{1}{2}$ in., and sustain the same amount of stress; the raised portion of the main tie sustains only a stress of $4\frac{1}{2}$ tons on the square inch, and might have been made a little lighter, but for the sake of appearance. The detail sketches attaching to the general drawing show the various modes of connection, and call for no special explanation; the glass here, as in some of the previous examples, is carried by ⊤ iron sash bars, placed at distances of 12 inches, with the exception of the glazed portions of the louvre roof and of the gable end, where the sashes are made of wood. The purlins are of ⊤ iron, excepting in those places where they carry the sashes, being there made of channel iron; owing to the great span between the principals, they are trussed, but might with safety have been a little lighter.

(*To be continued.*)

MANUFACTURING NUISANCES.

The question of nuisances arising from manufacturing operations is one which, in different shapes, has already been often before the public; and attempts have been made on the part of the legislature, at various times, to deal with this important subject; but such attempts have been attended only with partial success, and their effects have been but limited in extent. Now, however, the appointment of a Parliamentary committee, in accordance with a motion of the Earl of Derby, on the 9th July, promises to bring the matter forward in such a prominent and effective manner, that it will not only obtain that thorough consideration which its importance demands, but the subject having received the necessary elucidation, the laws relating thereto will, doubtless, be brought speedily into a more satisfactory state, both as regards those who are engaged in the manufacturing operations which are alleged to be the *fons mali* in such cases, and those who, having suffered either real or supposed injury, desire to seek legal protection and redress.

In the temperate and explanatory speech of Lord Derby, he very clearly showed, and even candidly stated as much, that if on the one hand, an inquiry into the subject of manufacturing nuisances be necessary for the protection of the public, it is equally necessary that the subject be approached with the greatest caution and with scrupulous regard for the immense manufacturing interests involved in the question. Indeed, in a manufacturing country like England, it behoves both the legislature and the press to enter upon the discussion of this subject with unusual forbearance and freedom from prejudice. The statistics furnished by Lord Derby himself prove that the amount of capital and manufacturing energy engaged in only one of the branches of trade likely to come under the investigation of the committee—viz., the alkali manufacture—is so great as to convince the most superficial observer that it would be an act of madness to enter upon a crusade against trade nuisances, except in the most guarded manner,—having a rational consideration for the character of the nuisance as well as for its extent; and bearing always in mind that, in a commercial sense, nuisances produced by the operations of any manufacture, must necessarily be brought into one of two classes, viz., nuisances preventible without such interference with the processes of the trade as will create an impediment to the ordinary progress of the manufacture; or nuisances which cannot be prevented without resorting to such radical changes in the manner of conducting the usual manufacturing operations, that to insist upon the removal of the nuisance is virtually to put a stop to the manufacture itself. If the subject be approached from a sanatory, and not a purely commercial point of view, of course such a classification would be insufficient, inasmuch as the sanatory considerations are properly held paramount to all others.

In dealing with the question of trade nuisances, it is often a very difficult thing for any person not absolutely practising a particular manufacture, to appreciate, even within extended limits, the peculiar points wherein any interruption to the usual routine of the manufacturing operations is likely either to be innoxious or to be attended with effects mischievous to the success of the whole process. And it is out of this that the difficulty arises of distinguishing between nuisances which are preventible and those which are irremediable, commercially speaking. Moreover, it is not from the difficulty or impossibility of modifying chemical processes alone that a nuisance may fall into the category of unpreventable nuisances—this may arise from commercial causes altogether independent of the manufacturing operations: for, in using measures to abate or destroy the nuisance, products may result for which there is no equivalent demand, or which are unsaleable substances, and it may be very difficult to dispose of these products.

Some years since, the usual means of purifying coal gas from the noxious sulphuretted hydrogen, with which it is contaminated in its crude state, was what was known as the wet-lime process. It consisted in passing the gas, as it issued from the retorts, through water and lime mixed to the consistency of thin cream: the lime, by its chemical affinity for the sulphur in the crude gas, was converted into the fœtid sulphide of calcium, so that the mixture discharged from the purifiers was almost inconceivably offensive. The great difficulty in the gas works works of that period was to get rid of this refuse. In removing from the gas the deleterious sulphuretted hydrogen, a new source of annoyance and difficulty had been created; and this may very well be the case in dealing with the question of trade nuisances of any kind. When Lord Derby selected the alkali manufacture as the principal illustration of his argument, he hit upon one of the very cases in which the manufacturer is not unlikely to find himself in the same position as the gas companies in respect to their refuse wet lime. The delinquency of the alkali manufacturers was, undoubtedly, stated fairly enough in Lord Derby's speech. There was no attempt on his part to exaggerate the extent of the injury which the emanations from these great chemical works inflict upon their neighbourhoods; but Lord Derby was mistaken when he came to the conclusion that all this is to be easily remedied: his own statements prove this, when he tells us that Mr. Muspratt paid, on three occasions, compensation altogether amounting to several thousand pounds, and finally pulled down his extensive works. It is quite obvious that the means of removing the nuisance, caused by those works, were neither simple nor indeed attainable by ordinary skill and care; if so, it is a very unlikely thing that so experienced and practical a manufacturer as Mr. Muspratt, should consent, in the first instance, to pay a large sum of money, and ultimately to sacrifice his costly works, whilst the means of avoiding all this loss lay within easy reach.

In the alkali manufacture, the first and most essential step consists in decomposing common salt by sulphuric acid; by this operation the whole of the chlorine of the salt is disengaged and discharged into the air in the form of gaseous muriatic acid. Some idea may be formed of the vast amount of this noxious gas which is produced in our alkali works, when it is remembered that it equals more than 60 per cent. by weight of the common salt employed. Mr. Gossage, in a paper read before the British Association at their last meeting at Manchester, stated that 260,000 tons of salt are consumed annually, in Great Britain, in the soda manufacture. From this quantity of salt about 156,000 tons of gaseous muriatic acid are produced. Some conception of the enormous quantity of alkali that is manufactured may be obtained from these figures; indeed it must be remembered that the consumption of the alkalies in this country goes *parri passu* with the glass and soap manufactures, and, in a less degree, with many other branches of industry. The whole of this great quantity of manufactured material can only, by the present system of manufacturing alkali, be produced through the step already spoken of, viz., the decomposition of common salt, and the evolution of muriatic acid gas, in the proportion of 60 per cent. by weight of the salt.

When we consider again, that 100lbs. of muriatic acid gas is equal in bulk to more than 1000 cubic feet, and that the 156,000 tons of gas already mentioned are equal in bulk to about 3,500,000,000 cubic feet, it will be seen that the quantity sent into the atmosphere in the neighbourhood of these works, must exercise a strong modifying influence upon the character of that atmosphere; *quo ad* the conditions of vegetable, if not of animal life. The magnitude of the evil being, however, admitted, it is not so easy to perceive how a remedy is to be found. It is assumed that, by taking advantage of the great solubility of muriatic acid gas in water, it is easy to absorb and condense all the gas into the liquid form: not only destroying a troublesome and noxious substance, but, by the same operation, converting it into a valuable commercial commodity. It is admitted by all that this can be done with the greatest ease, so far as the mere chemical operation is concerned, and that it has been long done at certain manufactories on the practical scale; but it is more difficult to prove that if all alkali manufacturers were compelled to adopt this process, the remedy would not be almost as bad as the evil. As water at 60° absorbs about 430 times its bulk of muriatic acid gas, it follows that the gas from 260,000 tons of salt—viz., 3,500,000,000 cubic feet—would produce (allowing for the dilation of the water by the absorption of the gas) more than 8,100,000 cubic feet, or at least 50,000,000 gallons of the liquid acid, of the strongest kind. But the consumption of liquid muriatic acid is not by any means unlimited, nor does it amount to anything like the consumption of sulphuric acid. Its applications in manufactures are, indeed, restricted, and if the whole of the muriatic acid gas from the alkali works in England were to be converted into liquid muriatic acid, the quantity produced would be far beyond what could be consumed; and the manufacturers would soon be overwhelmed by the accumulation of a material from which they would have no means of ridding themselves. The price paid for muriatic acid is, even now, in many localities, not remunerative; hence manufacturers who do condense the gas from their furnaces, are compelled, as Lord Derby stated, to let the liquid acid run into the neighbouring brooks; a proceeding quite as detrimental to the interests of their neighbours, as allowing it to escape from their chimnies into the air. It is not, however, our object to pursue any argument against the necessity for a stringent investigation into the subject of these trade nuisances, although it will be found much easier to apply theoretical than practical remedies. The true interests both of the public and of the great manufacturers, must lie in mutual agreement and support, and not in antagonism; but there can be no doubt that, in many cases, there is a strong disposition on the part of the latter to place themselves in opposition to the adoption of such improvements as are imperatively called for, as the consequence of increased population and the extension of these chemical manufactures.

Many trade nuisances are unquestionably no more an essential part of the manufacture than thick black smoke is of a well-constructed furnace, and they may be easily obviated, and would be, under the pressure of judicious legislation; but there are others which can no more be wholly removed, in a practical sense, at least, in the present state of our knowledge, than the sourness can be taken from vinegar. These are the cases which require to be approached with circumspection; but there is, at all events, one prospective good in Lord Derby's motion —the question is likely to be thoroughly investigated, and the interests of both public and manufacturer placed in a true and just position in respect to this subject.—*Newton's London Journal.*

TRIAL OF THE "BLACK PRINCE."

The official trial of the speed of this noble vessel, at full power, at her deep draught of water for sea service, commenced at Portsmouth on the 26th ult., under the most favourable circumstances of wind and weather. The two previous trials of the ship took place at light draught, and under somewhat exceptional circumstances, the first only being a trial of speed, made on the day after her arrival at Spithead from Greenock, on the 20th of November, 1861. The second was her trip outside the "Wight," to test the action of her enlarged rudder, in April last. In her speed trial she made four runs at the measured mile, with the following results in knots:—First run, 15·859; second run, 12·950; third run, 15·319, and fourth run, 13·043. Some disappointment was felt by many at the time at this rate of speed, the *Warrior* having exceeded it on her trial at deep draught, when she averaged 14·354 knots. Various causes were assigned to account for the difference between the two ships, but, perhaps, the real cause lay in the pressures of steam on board each vessel during the trial. At any rate this could be met and disposed of in the trial of the 26th. The ship's draught of water on the 20th of November was 24ft. 2in. aft, and 21ft. 10in. forward. The second trial (not of speed) took place in April last, when the ship was taken off the Culver cliffs, at the east end of the Isle of Wight. to test the capabilities of her rudder, which had been enlarged from an area of 130ft. to 153ft. On this occasion she had 12 men at her wheel, and, taking three of the circles completed by the ship as an average of the whole, they were made respectively in 8 min. 5 sec., 9 min. 49 sec., and 9 min. 38 sec.,—the angle of the rudder being in each case 16, 13, and 13 deg. The ship's draught of water was—forward, 22ft.; aft, 23ft. 1in. The *Black Prince* is now, however, in commission, with her stores on board and ready for sea, and made her trial of speed on the 26th on equal terms with her sister ship the *Warrior*, tried on the 17th of last October.

The ship was appointed to have her anchor short a-peak at Spithead by 9.30 a.m., and at that time the *Pheasant* gunboat embarked from the dockyard Capt. H. Broadhead and the officials appointed to execute the trial, and conveyed them out to the ship, which tripped her anchor at 10.30. From various causes, however, it was afternoon before the ship reached the trial ground, where four runs were made with the following results:—

	Time min.	Time sec.	Speed in knots.	Revolutions of engines.	Steam.	Vacuum. for.	Vacuum. aft.
First run	4	21......	13·846......	47·5......	20lb......	25	23
Second run	5	58......	10·055......	49	20lb......	25	23
Third run............	4	9......	14·457......	49	20lb......	24	23
Fourth run	5	58......	10·286......	49·5......	20lb......	24	23

Mean speed of the four runs, 12·209. This result was so unsatisfactory, as compared with the *Warrior's* trial, that ship having attained a mean speed of 14·354 knots, that it was resolved to abandon any further trial of speed, and to recommend to the Admiralty that the ship should be taken into the harbour and placed in dock to clean her bottom, and that the weight on her safety-valve should be increased to a level with that given to the *Warrior* on her trial trip, the *Black Prince* having been worked on the 26th with 5lb. less than the *Warrior*. The screws of both ships are precisely similar, improved Griffiths's, and set at the same pitch; the draught of water of the two vessels was, however, different, and against the *Black Prince*, whose draught was 26ft. 10in. aft, and 26ft. 2in. forward, the *Warrior* drew 26ft. 5in. aft, and 25ft. 6in. forward. There is certainly a vast difference in the speed of the two ships, which is not accounted for either by a foul bottom or the increased draught of water. Looking, however, to the load on the safety-valve in the two trials, we find in the five pounds difference in favour of the *Warrior* the cause of her, at present, superiority over the *Black Prince*; but, with a clean bottom and this difference in the weights rectified, it is expected that on the *Black Prince* resuming her trial, which it is intended she shall do this week, the speed of both ships will be found to be as nearly as possible equal. The determination having been arrived at by Captain Broadhead to postpone for the day any further trial of the ship's speed, she was taken off the trial ground and steered for the Bembridge lightship, to test her time in making complete circles to port and starboard. On reaching the desired position the vessel's helm was put hard to starboard, the ship at the time going at full speed, and the time being taken from the word of command being given. The half circle was made in 5 min. 4 sec., and the full circle in 10 min. 11 sec., the angle of the rudder being 15½ deg. Two and a half turns were got with the wheel, and the rudder was hove into position in 1 min. 3 sec.; revolutions of the engines, 45·5. With helm to port, the rudder was hove up to an angle of 16 deg. in 33 sec., with 3¼ turns of the wheel. The first half of the circle was made in 7 min., and the full circle completed in 13 min. 33 sec.; revolutions of engines, 45·5. In the third trial the engines were stopped and the helm put over to starboard before starting, and the circle was completed in somewhat less time. In the fourth trial, with the rudder amidships, the order was given to hard-a-port, and the rudder was hove over by the screw steering apparatus to 11 deg., the extent to which it could be got by this purchase, in 1 min. 20 sec. The ship's head was now turned towards Spithead, and in steaming in to the anchorage the engines were tested in their powers of changing their motion when at full speed. From the time of moving the handle of the telegraph on the bridge, to give the signal to the engine-room, they were stopped dead in 19 seconds, and were started ahead from standing still in 11 seconds, and to going ahead at full speed in 32 seconds. The temperature averaged during the trial was as follows:—After stoke-hole, 106 deg.; fore stoke-hole, 90½ deg.; engine-room, 96½ deg. No vibration whatever was felt in the ship throughout the day's trial. Even on the bridges nothing was felt beyond the slightly tremulous motion of the plank flooring between the stanchions. The engines, which were in charge of Mr. Tucker, the chief engineer of the ship, worked smoothly and satisfactorily throughout, and the boilers furnished a superfluity of steam.

STRENGTH OF CAST AND WROUGHT IRON PILLARS.

A SERIES OF TABLES DEDUCED FROM SEVERAL OF MR. EATON HODGKINSON'S FORMULÆ, SHOWING THE BREAKING WEIGHT AND SAFE WEIGHT OF CAST AND WROUGHT IRON UNIFORM CYLINDRICAL PILLARS.

BY WILLIAM BRYSON, C.E.

(*Continued from page* 181.)

Hollow Uniform Cylindrical Pillars of Cast Iron, both Ends being Flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in the Pillar in lbs.	Calculated breaking weight in tons from formulæ. $b=44·34\frac{D^{3·55}-d^{3·55}}{L^{1·7}}$ $Y=\frac{b\,c}{b+\frac{3}{4}c}$.	Safe weight in tons.	Safe weight, if irregularly fixed, in tons.
17	17	12	$10\frac{1}{2}$	1409·72	630·42	157·60	63·04
18	18	12	$10\frac{1}{2}$	1492·65	598·96	149·74	59·89
19	19	12	$10\frac{1}{2}$	1575·57	569·41	142·35	56·94
20	20	12	$10\frac{1}{2}$	1658·50	541·68	135·42	54·16
21	21	12	$10\frac{1}{2}$	1741·42	515·67	128·91	51·56
22	22	12	$10\frac{1}{2}$	1824·35	497·67	124·41	49·76
23	23	12	$10\frac{1}{2}$	1907·27	468·42	117·10	46·84
24	24	12	$10\frac{1}{2}$	1990·20	446·98	111·74	44·69
25	25	12	$10\frac{1}{2}$	2073·12	426·86	106·71	42·68
26	26	12	$10\frac{1}{2}$	2156·05	407·97	101·99	40·79
27	27	12	$10\frac{1}{2}$	2238·97	390·28	97·57	39·02
28	28	12	$10\frac{1}{2}$	2321·90	373·56	93·39	37·35
29	29	12	$10\frac{1}{2}$	2404·82	357·88	89·47	35·78
30	30	12	$10\frac{1}{2}$	2487·75	343·13	85·78	34·31
8	$7\frac{5}{13}$	13	$11\frac{1}{2}$	722·36	1124·08	281·02	112·40
9	$8\frac{4}{13}$	13	$11\frac{1}{2}$	812·66	1075·17	268·79	107·51
10	$9\frac{3}{13}$	13	$11\frac{1}{2}$	902·96	1026·87	256·71	102·68
11	$10\frac{2}{13}$	13	$11\frac{1}{2}$	993·25	979·67	244·91	97·96
12	$11\frac{1}{13}$	13	$11\frac{1}{2}$	1083·55	933·92	233·48	93·39
13	12	13	$11\frac{1}{2}$	1173·84	889·86	222·46	88·98
14	$12\frac{12}{13}$	13	$11\frac{1}{2}$	1264·14	847·66	211·91	84·76
15	$13\frac{11}{13}$	13	$11\frac{1}{2}$	1354·44	807·40	201·85	80·74
16	$14\frac{10}{13}$	13	$11\frac{1}{2}$	1444·73	769·13	192·28	76·91
17	$15\frac{9}{13}$	13	$11\frac{1}{2}$	1535·03	732·83	183·20	73·28
18	$16\frac{8}{13}$	13	$11\frac{1}{2}$	1625·32	698·50	174·62	69·85
19	$17\frac{7}{13}$	13	$11\frac{1}{2}$	1715·62	666·04	166·51	66·60
20	$18\frac{6}{13}$	13	$11\frac{1}{2}$	1805·92	635·40	158·85	63·54
21	$19\frac{5}{13}$	13	$11\frac{1}{2}$	1896·21	606·52	151·63	60·65
22	$20\frac{4}{13}$	13	$11\frac{1}{2}$	1986·51	579·29	144·82	57·92
23	$21\frac{3}{13}$	13	$11\frac{1}{2}$	2076·80	553·53	138·40	55·36
24	$22\frac{2}{13}$	13	$11\frac{1}{2}$	2167·10	529·46	132·36	52·94
25	$23\frac{1}{13}$	13	$11\frac{1}{2}$	2257·40	506·69	126·67	50·66
26	24	13	$11\frac{1}{2}$	2347·69	485·21	121·30	48·52
27	$24\frac{12}{13}$	13	$11\frac{1}{2}$	2437·99	464·97	116·24	46·49
28	$25\frac{11}{13}$	13	$11\frac{1}{2}$	2528·28	445·88	111·47	44·58
29	$26\frac{10}{13}$	13	$11\frac{1}{2}$	2618·58	427·87	106·96	42·78
30	$27\frac{9}{13}$	13	$11\frac{1}{2}$	2708·88	410·87	102·71	41·08

Solid Uniform Cylindrical Pillars of Wrought Iron, both Ends being Rounded or Irregularly Fixed.

Length or height of pillar in feet.	Number of diameters contained in the length or height.	Diameter in inches.	Calculated breaking weight in tons from other formulæ.	Calculated breaking weight in tons from formula, $W=42·8\frac{D^{3·76}}{L^2}$.	Safe weight in tons.
5	20	3	72·88	......	18·22
6	24	3	59·45	......	14·86
7	28	3	48·83	......	12·20
8	32	3	40·47	......	10·11
9	36	3	......	32·88	8·22
10	40	3	......	26·63	6·65
11	44	3	......	22·01	5·50
12	48	3	......	18·49	4·62
13	52	3	......	15·75	3·93
14	56	3	......	13·58	3·39
15	60	3	......	11·83	2·95
16	64	3	......	10·40	2·60
17	68	3	......	9·21	2·30
18	72	3	......	8·22	2·05
19	76	3	......	7·37	1·84
20	80	3	......	6·65	1·66
5	17·142	$3\frac{1}{2}$	112·99	......	28·24
6	20·571	$3\frac{1}{2}$	94·47	......	23·61
7	24	$3\frac{1}{2}$	79·13	......	19·78
8	27·428	$3\frac{1}{2}$	66·65	......	16·66
9	30·857	$3\frac{1}{2}$	56·54	......	14·13
10	34·285	$3\frac{1}{2}$	......	47·55	11·88
11	37·714	$3\frac{1}{2}$	......	39·29	9·82
12	41·142	$3\frac{1}{2}$	......	33·02	8·25
13	44·571	$3\frac{1}{2}$	......	28·13	7·03
14	48	$3\frac{1}{2}$	......	24·26	6·06
15	51·428	$3\frac{1}{2}$	......	21·13	5·28
16	54·857	$3\frac{1}{2}$	......	18·57	4·64
17	58·284	$3\frac{1}{2}$	......	16·45	4·11
18	61·714	$3\frac{1}{2}$	......	14·67	3·66
19	65·142	$3\frac{1}{2}$	......	13·17	3·29
20	68·571	$3\frac{1}{2}$	......	11·88	2·97
5	15	4	162·77	......	40·69
6	18	4	139·00	......	34·75
7	21	4	118·54	......	29·63
8	24	4	101·34	......	25·33
9	27	4	87·02	......	21·75
10	30	4	75·15	......	18·78
11	33	4	......	64·92	16·23
12	36	4	......	54·55	13·63
13	39	4	......	46·48	11·62
14	42	4	......	40·07	10·01
15	45	4	......	34·91	8·72
16	48	4	......	30·68	7·67
17	51	4	......	27·18	6·79
18	54	4	......	24·24	6·06
19	57	4	......	21·76	5·44
20	60	4	......	19·63	4·90

Solid Uniform Cylindrical Pillars of Wrought Iron, both Ends being Rounded or Irregularly Fixed.

Length or height of pillar in feet.	Number of diameters contained in the length or height.	Diameter in inches.	Calculated breaking weight in tons from other formulæ.	Calculated breaking weight in tons from formula, $W = 42{\cdot}8 \frac{D^{3{\cdot}76}}{L^2}$.	Safe weight in tons.
5	13·333	4½	222·17	...	55·54
6	16	4½	193·21	...	48·30
7	18·666	4½	167·43	...	41·85
8	21·333	4½	145·08	...	36·27
9	24	4½	125·98	...	31·48
10	26·666	4½	109·72	...	27·43
11	29·333	4½	96·27	...	24·06
12	32	4½	84·94	...	21·23
13	34·666	4½	...	72·38	18·09
14	37·333	4½	...	62·41	15·60
15	40	4½	...	54·36	13·59
16	42·666	4½	...	47·78	11·94
17	45·333	4½	...	42·32	10·58
18	48	4½	...	37·75	9·43
19	50·666	4½	...	33·88	8·47
20	53·333	4½	...	30·58	7·64
5	12	5	291·07	...	72·76
6	14·4	5	257·10	...	64·27
7	16·8	5	225·94	...	56·48
8	19·2	5	198·22	...	49·55
9	21·6	5	174·02	...	43·50
10	24	5	153·12	...	38·28
11	26·4	5	135·20	...	33·80
12	28·8	5	119·80	...	29·95
13	31·2	5	106·64	...	26·66
14	33·6	5	...	92·74	23·18
15	36	5	...	80·79	20·19
16	38·4	5	...	71·01	17·75
17	40·8	5	...	62·90	15·72
18	43·2	5	...	56·10	14·02
19	45·6	5	...	50·35	12·58
20	48	5	...	45·44	11·36
5	10	6	456·78	...	114·19
6	12	6	413·58	...	103·39
7	14	6	372·00	...	93·00
8	16	6	333·14	...	83·28
9	18	6	298·21	...	74·55
10	20	6	266·78	...	66·69
11	22	6	238·95	...	59·73
12	24	6	214·45	...	53·61
13	26	6	192·95	...	48·23
14	28	6	174·09	...	43·52
15	30	6	157·56	...	39·39
16	32	6	...	140·95	35·23
17	34	6	...	124·86	31·21
18	36	6	...	111·37	27·84
19	38	6	...	99·95	24·98
20	40	6	...	90·21	22·55

Hollow Uniform Cylindrical Pillars of Cast Iron, both Ends being Flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in pillar in lbs.	Calculated breaking weight in tons from formula, $W = 44{\cdot}34 \frac{D^{3{\cdot}55} - d^{3{\cdot}55}}{L^{1{\cdot}7}}$	Calculated breaking weight in tons from formula, $Y = \frac{b\,c}{b + \frac{3}{4}c}$	Safe weight in tons.	Safe weight, if irregularly fixed, in tons.
5	30	2	1	36·85	...	30·28	7·57	3·02
6	36	2	1	44·22	22·58	...	5·64	2·25
7	42	2	1	51·59	17·37	...	4·34	1·73
8	48	2	1	58·96	13·85	...	3·46	1·38
9	54	2	1	66·33	11·33	...	2·83	1·13
10	60	2	1	73·70	9·47	...	2·36	0·94
11	66	2	1	81·07	8·06	...	2·01	0·80
12	72	2	1	88·44	6·95	...	1·73	0·69
13	78	2	1	95·81	6·06	...	1·51	0·60
14	84	2	1	103·18	5·34	...	1·33	0·53
15	90	2	1	110·55	4·75	...	1·18	0·47
16	96	2	1	117·92	4·26	...	1·06	0·42
17	102	2	1	125·29	3·84	...	0·96	0·38
18	108	2	1	132·66	3·48	...	0·87	0·34
19	114	2	1	140·03	3·18	...	0·79	0·31
20	120	2	1	147·40	2·91	...	0·72	0·29
5	20	3	2	61·42	...	82·51	20·62	8·25
6	24	3	2	73·71	...	68·32	17·08	6·83
7	28	3	2	85·99	...	57·26	14·31	5·72
8	32	3	2	98·28	48·73	...	12·18	4·87
9	36	3	2	110·56	39·88	...	9·97	3·98
10	40	3	2	122·85	33·34	...	8·33	3·33
11	44	3	2	135·13	28·35	...	7·08	2·83
12	48	3	2	147·42	24·45	...	6·11	2·44
13	52	3	2	159·70	21·34	...	5·33	2·13
14	56	3	2	171·99	18·81	...	4·70	1·88
15	60	3	2	184·27	16·73	...	4·18	1·67
16	64	3	2	196·56	14·99	...	3·74	1·49
17	68	3	2	208·84	13·49	...	3·37	1·34
18	72	3	2	221·13	12·27	...	3·06	1·22
19	76	3	2	233·41	11·20	...	2·80	1·12
20	80	3	2	245·70	10·26	...	2·56	1·02
5	15	4	3	85·99	...	149·60	37·40	14·96
6	18	4	3	103·19	...	128·79	32·19	12·87
7	21	4	3	120·39	...	111·37	27·84	11·13
8	24	4	3	136·59	...	96·88	24·22	9·68
9	27	4	3	154·79	...	84·84	21·21	8·48
10	30	4	3	171·99	...	74·79	18·69	7·47
11	33	4	3	189·18	66·04	...	16·51	6·60
12	36	4	3	206·38	56·96	...	14·24	5·69
13	39	4	3	223·58	49·71	...	12·42	4·97
14	42	4	3	240·78	43·83	...	10·95	4·38
15	45	4	3	257·98	38·98	...	9·74	3·89
16	48	4	3	275·18	34·93	...	8·73	3·49
17	51	4	3	292·38	31·50	...	7·87	3·15
18	54	4	3	309·58	28·59	...	7·14	2·85
19	57	4	3	326·78	26·01	...	6·50	2·60
20	60	4	3	343·98	23·90	...	5·97	2·39

Hollow Uniform Cylindrical Pillars of Cast Iron, both Ends being Flat and Firmly Fixed.

Length or height of pillar in feet.	No. of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in pillar in lbs.	Calculated breaking weight in tons from formula, $W=44{\cdot}34\frac{D^{3\cdot55}-d^{3\cdot55}}{L^{1\cdot7}}$	Calculated breaking weight in tons from formula, $Y=\frac{b\,c}{b+\frac{3}{4}c}$	Safe weight in tons.	Safe weight, if irregularly fixed, in tons.
5	12	5	4	110·56		224·13	56·03	22·41
6	14·4	5	4	132·67		198·66	49·66	19·86
7	16·8	5	4	154·79		176·16	44·04	17·61
8	19·2	5	4	176·90		156·55	39·13	15·65
9	21·6	5	4	199·01		139·59	34·89	13·95
10	24	5	4	221·13		124·96	31·24	12·49
11	26·4	5	4	243·24		112·33	28·08	11·23
12	28·8	5	4	265·35		101·41	25·35	10·14
13	31·2	5	4	287·46		91·93	22·98	9·19
14	33·6	5	4	309·58	82·75		20·68	8·27
15	36	5	4	331·69	73·59		18·39	7·35
16	38·4	5	4	353·80	65·95		16·48	6·59
17	40·8	5	4	375·92	59·49		14·87	5·94
18	43·2	5	4	398·03	53·98		13·49	5·39
19	45·6	5	4	420·14	49·24		12·31	4·92
20	48	5	4	442·26	45·12		11·28	4·51
5	10	6	5	153·13		302·25	75·56	30·22
6	12	6	5	162·16		273·80	68·45	27·38
7	14	6	5	189·18		247·60	61·90	24·76
8	16	6	5	216·21		223·91	55·97	22·39
9	18	6	5	243·24		202·74	50·68	20·27
10	20	6	5	270·27		183·94	45·98	18·39
11	22	6	5	297·29		167·29	41·82	16·72
12	24	6	5	324·32		152·58	38·14	15·25
13	26	6	5	351·35		139·57	34·89	13·95
14	28	6	5	378·37		128·04	82·01	12·80
15	30	6	5	405·40		117·82	29·45	11·78
16	32	6	5	432·43		108·72	27·18	10·87
17	34	6	5	459·45	98·97		24·74	9·89
18	36	6	5	486·48	89·81		22·45	8·98
19	38	6	5	513·51	81·92		20·48	8·19
20	40	6	5	540·54	75·08		18·77	7·50
8	$10\frac{2}{3}$	9	8	334·15		449·65	112·41	44·96
10	$13\frac{1}{3}$	9	8	417·69		392·96	98·24	39·29
12	16	9	8	501·22		343·17	85·79	34·31
14	$18\frac{2}{3}$	9	8	584·76		300·38	75·09	30·03
16	$21\frac{1}{3}$	9	8	668·30		263·99	65·99	26·39
18	24	9	8	751·84		233·16	58·29	23·31
20	$26\frac{2}{3}$	9	8	835·38		207·02	51·75	20·70
8	8	12	11	450·84		687·29	171·82	68·72
10	10	12	11	563·55		623·61	155·90	62·36
12	12	12	11	676·26		563·51	140·87	56·35
14	14	12	11	788·97		508·43	127·10	50·84
16	16	12	11	901·68		458·85	114·71	45·88
18	18	12	11	1014·39		414·71	103·67	41·47
20	20	12	11	1127·10		375·64	93·91	37·56

Hollow Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in the Pillar, in lbs.	Calculated breaking weight in tons from formulæ, $b=44{\cdot}34\frac{D^{3\cdot55}-d^{3\cdot55}}{L^{1\cdot7}}$ $Y=\frac{b\,c}{b+\frac{3}{4}c}$.	Safe weight in tons.	Safe weight if irregularly fixed, in tons.
8	$6\frac{6}{7}$	14	$12\frac{1}{2}$	781.33	1245·02	311·25	124·50
9	$7\frac{5}{7}$	14	$12\frac{1}{2}$	879·00	1195·69	298·92	119·56
10	$8\frac{4}{7}$	14	$12\frac{1}{2}$	976·67	1146.57	286·64	114·65
11	$9\frac{3}{7}$	14	$12\frac{1}{2}$	1074·33	1098·19	274·54	109·81
12	$10\frac{2}{7}$	14	$12\frac{1}{2}$	1172·00	1050·93	262·73	105·09
13	$11\frac{1}{7}$	14	$12\frac{1}{2}$	1269·67	1005·07	251.26	100·50
14	12	14	$12\frac{1}{2}$	1367·33	960·82	240·25	96·08
15	$12\frac{6}{7}$	14	$12\frac{1}{2}$	1465·00	918·32	229·58	91·83
16	$13\frac{5}{7}$	14	$12\frac{1}{2}$	1562·67	877·64	219·41	87·76
17	$14\frac{4}{7}$	14	$12\frac{1}{2}$	1660·33	838·81	209·70	83·88
18	$15\frac{3}{7}$	14	$12\frac{1}{2}$	1758·00	801·87	200·46	80·18
19	$16\frac{2}{7}$	14	$12\frac{1}{2}$	1855·67	766·73	191·68	76·67
20	$17\frac{1}{7}$	14	$12\frac{1}{2}$	1953·34	733·40	183·35	73·34
21	18	14	$12\frac{1}{2}$	2051·00	701·81	175·45	70·18
22	$18\frac{6}{7}$	14	$12\frac{1}{2}$	2148·67	671·88	167·97	67·18
23	$19\frac{5}{7}$	14	$12\frac{1}{2}$	2246·34	643·55	160·88	64·35
24	$20\frac{4}{7}$	14	$12\frac{1}{2}$	2344·00	616·75	154·18	61·67
25	$21\frac{3}{7}$	14	$12\frac{1}{2}$	2441·67	591·39	147·84	59·13
26	$22\frac{2}{7}$	14	$12\frac{1}{2}$	2539·34	567·39	141·84	56·73
27	$23\frac{1}{7}$	14	$12\frac{1}{2}$	2637·00	544·68	136·17	54·46
28	24	14	$12\frac{1}{2}$	2734·67	523·20	130·80	52.32
29	$24\frac{6}{7}$	14	$12\frac{1}{2}$	2832·34	502·86	125·71	50·28
30	$25\frac{5}{7}$	14	$12\frac{1}{2}$	2930·01	483·59	120·89	48·35
8	$6\frac{2}{5}$	15	$13\frac{1}{2}$	840·30	1366·04	341·51	136·60
9	$7\frac{1}{5}$	15	$13\frac{1}{2}$	945·34	1316·52	329·13	131·65
10	8	15	$13\frac{1}{2}$	1050·38	1266·86	316·71	126·68
11	$8\frac{4}{5}$	15	$13\frac{1}{2}$	1155·41	1217·62	304·40	121·76
12	$9\frac{3}{5}$	15	$13\frac{1}{2}$	1260·45	1169·18	292·29	116·91
13	$10\frac{2}{5}$	15	$13\frac{1}{2}$	1365·49	1121·86	280·46	112·18
14	$11\frac{1}{5}$	15	$13\frac{1}{2}$	1470·43	1075·91	268·97	107·59
15	12	15	$13\frac{1}{2}$	1575·47	1031·49	257·87	103·14
16	$12\frac{4}{5}$	15	$13\frac{1}{2}$	1680·60	988·72	247·18	98·87
17	$13\frac{3}{5}$	15	$13\frac{1}{2}$	1785·64	947·66	236·91	94·76
18	$14\frac{2}{5}$	15	$13\frac{1}{2}$	1890·68	908·38	227·09	90·83
19	$15\frac{1}{5}$	15	$13\frac{1}{2}$	1995·72	870·82	217·70	87·08
20	16	15	$13\frac{1}{2}$	2100·76	835·00	208·75	83·50
21	$16\frac{4}{5}$	15	$13\frac{1}{2}$	2205·79	800·90	200·22	80·09
22	$17\frac{3}{5}$	15	$13\frac{1}{2}$	2310·83	768·44	192·11	76·84
23	$18\frac{2}{5}$	15	$13\frac{1}{2}$	2415·87	737·59	184·39	73·75
24	$19\frac{1}{5}$	15	$13\frac{1}{2}$	2520·91	708·28	177·07	70·82
25	20	15	$13\frac{1}{2}$	2625·95	680·44	170·11	68·04
26	$20\frac{4}{5}$	15	$13\frac{1}{2}$	2730·98	753·99	163·49	65·39
27	$21\frac{3}{5}$	15	$13\frac{1}{2}$	2836·02	628·87	157·21	62·88
28	$22\frac{2}{5}$	15	$13\frac{1}{2}$	2941·06	605·05	151·26	60·50
29	$23\frac{1}{5}$	15	$13\frac{1}{2}$	3046·10	582·41	145·60	58·24
30	24	15	$13\frac{1}{2}$	3151·14	560·91	140·22	56·09

Solid Uniform Cylindrical Pillars of Wrought Iron, both Ends being Rounded or Irregularly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	Diameter in inches.	Calculated breaking weight in tons from other formulæ.	Calculated breaking weight in tons from formula, $W=42{\cdot}8\frac{D^{3.76}}{L^2}$.	Safe weight in tons.
5	30	2	21·10	....	5·27
6	36	2	....	16·10	4·02
7	42	2	....	11·83	2·95
8	48	2	....	9·05	2·26
9	54	2	....	7·15	1·78
10	60	2	....	5·79	1·44
11	66	2	....	4·79	1·19
12	72	2	....	4·02	1·00
13	78	2	....	3·43	0·85
14	84	2	....	2·95	0·73
15	90	2	....	2·57	0·64
16	96	2	....	2·26	0·56
17	102	2	....	2·00	0·50
18	108	2	....	1·78	0·44
19	114	2	....	1·60	0·40
20	120	2	....	1·44	0·36
5	24	$2\frac{1}{2}$	42·34	....	10·58
6	28·8	$2\frac{1}{2}$	33·58	....	8·39
7	33·6	$2\frac{1}{2}$	....	27·34	6·83
8	38·4	$2\frac{1}{2}$	....	20·93	5·23
9	43·2	$2\frac{1}{2}$	....	16·54	4·13
10	48	$2\frac{1}{2}$	....	13·39	3·34
11	52·8	$2\frac{1}{2}$	....	11·07	2·76
12	57·6	$2\frac{1}{2}$	....	9·30	2·32
13	62·4	$2\frac{1}{2}$	....	7·92	1·98
14	67·2	$2\frac{1}{2}$	....	6·83	1·70
15	72	$2\frac{1}{2}$	....	5·95	1·48
16	76·8	$2\frac{1}{2}$	....	5·23	1·30
17	81·6	$2\frac{1}{2}$	....	4·63	1·15
18	86·4	$2\frac{1}{2}$	....	4·13	1·03
19	91·2	$2\frac{1}{2}$	....	3·71	0·92
20	96	$2\frac{1}{2}$	....	3·34	0·83

Hollow Uniform Cylindrical Pillars of Cast Iron, Both Ends being Flat and Firmly Fixed.

Length or height of Pillar in feet.	Number of diameters contained in the length or height.	External diameter in inches.	Internal diameter in inches.	Calculated weight of metal contained in the Pillar, in lbs.	Calculated breaking weight in tons from formulæ, $b=44{\cdot}34\frac{D^{3.55}-d^{3.55}}{L^{1.7}}$ $Y=\frac{b\,c}{b+\frac{3}{4}c}$.	Safe weight in tons.	Safe weight if irregularly fixed, in tons.
8	6	16	$14\frac{1}{2}$	899·27	1487·02	371·75	148·70
9	$6\frac{3}{4}$	16	$14\frac{1}{2}$	1011·68	1437·50	359·37	143·75
10	$7\frac{1}{2}$	16	$14\frac{1}{2}$	1124·09	1387·54	346·88	138·75
12	9	16	$14\frac{1}{2}$	1348·90	1288·34	322·08	128·33
15	$11\frac{1}{4}$	16	$14\frac{1}{2}$	1686·13	1146·46	286·61	114·64
20	15	16	$14\frac{1}{2}$	2241·48	939·67	234·91	93·96
8	$5\frac{11}{17}$	17	$15\frac{1}{2}$	958·24	1607·94	401·98	160·79
10	$7\frac{1}{17}$	17	$15\frac{1}{2}$	1197·80	1508·47	377·11	150·84
12	$8\frac{8}{17}$	17	$15\frac{1}{2}$	1437·36	1408·20	352·05	140·82
15	$10\frac{10}{17}$	17	$15\frac{1}{2}$	1796·70	1262·90	315·72	126·29
20	$14\frac{2}{17}$	17	$15\frac{1}{2}$	2395·60	1047·01	261·75	104·70
8	$5\frac{1}{3}$	18	$16\frac{1}{2}$	1017·20	1728·69	432·17	172·86
10	$6\frac{2}{3}$	18	$16\frac{1}{2}$	1271·50	1629·46	407·36	162·94
12	8	18	$16\frac{1}{2}$	1525·80	1528·49	382·12	152·84
15	10	18	$16\frac{1}{2}$	1907·25	1380·42	345·10	138·04
20	$13\frac{1}{3}$	18	$16\frac{1}{2}$	2543·00	1156·53	289·13	115·65
10	$5\frac{15}{21}$	21	19	1965·50	2616·54	654·13	261·65
15	$8\frac{12}{21}$	21	19	2948·25	2277·34	569·33	227·73
20	$11\frac{9}{21}$	21	19	3931·00	1956·15	489·03	195·61
10	5	24	22	2260·20	3099·32	774·83	309·93
15	$7\frac{1}{2}$	24	22	3390·30	2758·42	689·60	275·84
20	10	24	22	4520·40	2421·21	605·30	242·12

TIMBER PILLARS.

The following formulæ are appliacable for the breaking weight of solid cylindrical pillars of Dantzic Oak and Red Deal, both ends being flat and firmly fixed, and the length of the pillars exceeding 30 diameters and upwards :—

Dantzic Oak.........$W = 6{\cdot}71\ \frac{D^4}{L^2}$ Red Deal ....$W = 3{\cdot}74\ \frac{D^4}{L^2}$

Dantzic Oak.........$W = 4{\cdot}81\ \frac{D^{3.55}}{L^{1.7}}$ Red Deal ....$W = 3{\cdot}47\ \frac{D^{3.55}}{L^{1.7}}$

ROYAL INSTITUTION OF GREAT BRITAIN.

ON GAS FURNACES, &c.

BY M. FARADAY, ESQ., D.C.L., LL.D., F.R.S.

The subject of the evening was gas-glass furnaces, and having arisen almost extemporaneously, it resolved itself chiefly into an account of the manner in which Mr. Siemens has largely and practically applied gas, combined with the use of his heat regenerator, to the ignition of all kinds of great furnaces. Gas has been used to supply heat, even upon a very large scale, in some of the iron blast furnaces, and heat which has done work once has been carried back in part to the place from whence it came to repeat its service; but Mr. Siemens has combined these two points, and successfully applied them in a great variety of cases—as the potter's kiln—the enameller's furnace—the zinc-distilling furnace—the tube welding furnace—the metal-melting furnace—the iron-puddling furnace—and the glass furnace, either for covered or open pots—so as to obtain the highest heat required over any extent of space, with great facility of management, and with great economy (one-half) of fuel. The glass furnace described had an area of 28 feet long and 14 feet wide, and contained eight open pots each holding nearly two tons of material.

The gaseous fuel is obtained by the mutual action of coal, air, and water, at a moderate red heat. A brick chamber, perhaps 6ft. by 12 and about 10ft. high, has one of its end walls converted into a fire grate, *i.e.* about half way down it is solid plate, and for the rest of the distance consists of strong horizontal plate bars where air enters; the whole being at an inclination such as that which the side of a heap of coals would naturally take. Coals are poured, through openings above, upon this combination of wall and grate, and being fired at the under-surface, they burn at the place where the air enters; but as the layer of coal is from 2 to 3ft. thick, various operations go on in those parts of the fuel which cannot burn for want of air. Thus the upper and cooler part of the coal produces a larger body of hydro-carbons; the cinders or coke which are not volatilized, approach, in descending, towards the grate; that part which is nearest the grate burns with the entering air into carbonic acid, and the heat evolved ignites the mass above it, the carbonic acid passing slowly through the ignited carbon, becomes converted into carbonic oxide, and mingles in the upper part of the chamber (or gas producer) with the former hydro-carbons. The water, which is purposely introduced at the bottom of the arrangement, is first vaporized by the heat, and then decomposed by the ignited fuel and re-arranged as hydrogen and carbonic oxide; and only the ashes of the coal are removed as solid matter from the chamber at the bottom of the fire-bars.

These mixed gases form the gaseous fuel. The nitrogen which entered with the air at the grate is mingled with them, constituting about a third of the whole volume. The gas rises up a large vertical tube for 12 or 15ft., after which it proceeds horizontally for any required distance, and then descends to the heat-regenerator, through which it passes before it enters the furnaces. A regenerator is a chamber packed with fire-bricks, separated so as to allow of the free passage of air or gas between them. There are four placed under a furnace. The gas ascends through one of these chambers, whilst air ascends through the neighbouring chamber, and both are conducted through passage outlets at one end of the furnace, where mingling they burn, producing the heat due to their chemical action. Passing onwards to the other end of the furnace, they (*i.e.* the combined gases) find precisely similar outlets down which they pass; and traversing the two remaining regenerators from above downwards, heat them intensely, especially the upper part, and so travel on in their cooled state to the shaft or chimney. Now the passages between the four regenerators and the gas and air are supplied with valves and deflecting plates, some of which are like four way-cocks in their action; so that by the use of a lever these regenerators and air-ways, which were carrying off the expended fuel, can in a moment be used for conducting air and gas into the furnace; and those which just before had served to carry air and gas into the furnace now takes the burnt fuel away to the stack. It is to be observed, that the intensely heated flame which leaves the furnace for the stack always proceeds downwards through the regenerators, so that the upper part of them is most intensely ignited, keeping back, as it does, the intense heat; and so effectual are they in this action, that the gas which enters the stack to be cast into the air is not usually above 300°F. of heat. On the other hand, the entering gas and air always passes upwards through the regenerator, so that they attain a temperature equal to white heat before they meet in the furnace, and there add to the carried heat that due to their mutual chemical action. It is considered that when the furnace is in full order, the heat carried forward to be evolved by the chemical action of combustion is about 4000°, whilst that carried back by the regenerators is about 3000°, making an intensity of power which, unless moderated on purpose, would fuze furnace and all exposed to its action.

Thus the regenerators are alternately heated and cooled by the outgoing and entering gas and air, and the time for the alternation is from half an hour to an hour, as observation may indicate. The motive power on the gas is of two kinds —a slight excess of pressure within is kept up from the gas-producer to the bottom of the regenerator to prevent air entering and mingling with the fuel before it is burnt; but from the furnace, downwards through the regenerators, the advance of the heated medium is governed mainly by the draught in the tall stack, or chimney.

Great facility is afforded in the management of these furnaces. If, whilst glass is in the course of manufacture, an intense heat is required, an abundant supply of gas and air is given; when the glass is made, and the condition has to be reduced to working temperature, the quantity of fuel and air is reduced. If the combustion in the furnace is required to be gradual from end to end, the inlets of air and gas are placed more or less apart the one from the other. The gas is lighter than the air; and if a rapid evolution of heat is required as in a short puddling furnace, the mouth of the gas inlet is placed below that of the air inlet; if the reverse is required, as in the long tube-welding furnace, the contrary arrangement is used. Sometimes, as in the enameller's furnace, which is a long muffle, it is requisite that the heat be greater at the door end of the muffle and furnace, because the goods, being put in and taken out at the same end, those which enter last and are withdrawn first, remain, of course, for a shorter time in the heat at that end; and though the fuel and air enters first at one end and then at the other, alternately, still the necessary difference of temperature is preserved by the adjustment of the apertures at those ends.

Not merely can the supply of gas and air to the furnace be governed by valves in the passages, but the very manufacture of the gas fuel itself can be diminished, or even stopped, by cutting off the supply of air to the grate of the gas producer; and this is important, inasmuch as there is no gasometer to receive and preserve the aeriform fuel, for it proceeds at once to the furnaces.

Some of the furnaces have their contents open to the fuel and combustion, as in the puddling and metal-melting arrangements; others are enclosed, as in the muffle furnaces and the flint-glass furnaces. Because of the great cleanliness of the fuel, some of the glass furnaces, which before had closed pots, now have them open, with great advantage to the working and no detriment to the colour.

The economy in the fuel is esteemed practically as one-half, even when the same kind of coal is used, either directly for the furnace or for the gas producer; but, as in the latter case, the most worthless kind can be employed—such as slack, &c., which can be converted into a clean gaseous fuel at a distance from the place of the furnace, so, many advantages seem to present themselves in this part of the arrangement.

It will be seen that the system depends, in a great measure, upon the intermediate production of carbonic oxide from coal instead of the direct production of carbonic acid. Now, carbonic oxide is poisonous, and, indeed, both these gases are very deleterious. Carbonic acid must at last go into the atmosphere; but the carbonic oxide ceases to exist at the furnace, its time is short, and whilst existing it is confined on its way from the gas-producer to the furnace, where it becomes carbonic acid. No signs of harm from it have occurred, although its application has been made in thirty furnaces or more.

The following are some numbers that were used to convey general impressions to the audience. Carbon burnt perfectly into carbonic acid in a gas-producer would evolve about 4000° of heat; but, if burnt into carbonic oxide, it would evolve only 1200°. The carbonic oxide, in its fuel form, carries on with it the 2800° in chemical force, which it evolves when burning in the real furnace with a sufficient supply of air. The remaining 1200° are employed in the gas-producer in distilling hydro-carbons, decomposing water, &c. The whole mixed gaseous uel can evolve about 4000° in the furnace, to which the regenerator can return bout 3000° more.

ON THE PROPERTIES OF IRON, AND ITS RESISTANCE TO PROJECTILES AT HIGH VELOCITIES.

By William Fairbairn, Esq., F.R.S.

We have no correct record as to the exact time when wrought-iron plates were first employed for the purpose of building vessels. It is, however, certain that iron barges were in use on canals at the close of the last century. In 1824 Mr. Manley, of Staffordshire, built an iron steam-boat for the navigation of the river Seine, and this was the first iron vessel that attempted a sea voyage. She was navigated from this country to Havre, by the late Admiral Sir Charles Napier, and although constructed for shallow rivers, she nevertheless crossed the channel in perfect safety. From that time to 1830 no attempt was made to build iron vessels, and nothing was done towards ascertaining the properties of iron as a material for ship-building.

A series of experiments instituted by the Forth and Clyde Canal Company in 1829-30, to ascertain the law of traction of light boats at high velocities on canals led to the application of iron for the construction of vessels, and the lightness of these new vessels, combined with their increased strength, suggested the extended application of the material in the construction of vessels of much larger dimensions, and ultimately to those of the largest class both in the war and the mercantile navy. Considerable difficulty, however, existed with regard to the navy; and although the principle of iron construction as applied to merchant vessels and packets was fully established, it was nevertheless considered inapplicable, until of late years, for ships of war. It is true that until the new system of casing the sides of vessels, first introduced by the Emperor of the French in 1854, was established, the iron ship was even more dangerous under fire than one built entirely of wood. Now, however, that thick iron plates are found sufficiently strong, under ordinary circumstances, to resist the action of guns, not exceeding 120-pounders, for a considerable length of time, the state of the navy and the minds of our naval officers have entirely changed. We must, therefore, now look to new conditions, new materials, and an entirely new construction, if we are to retain our superiority as *mistress of the seas.* There yet remain amongst us those who contend for the wooden walls, but they are no longer applicable to the wants of the state; and I am clearly of opinion that we cannot afford to trifle with so important a branch of the public service as to fall behind any nation, however powerful and efficient they may be in naval construction. Having satisfied ourselves that this desideratum must be attained, at whatever cost, I shall now endeavour to point out such facts as, in my opinion, relate to the changes that are now before us, and simply endeavour to show—

1st. The description of iron best calculated to secure strength and durability in the construction of ships of war.

2nd. The distribution and best forms of construction to attain this object; and

Lastly. The properties of iron best calculated to resist the penetration of shot at high velocities.

Properties of Iron.

If we are desirous to attain perfection in mechanical, architectural, or ship-building construction, it is essential that the engineer or architect should make himself thoroughly acquainted with the properties of the materials which he employs. It is unimportant whether the construction be a house, a ship, or a bridge. We must possess correct ideas of the strength, proportion, and combination of the parts, before we can arrive at satisfactory results; and to effect these objects the naval architect should be conversant with the following facts relating to the resisting powers of malleable and rolled iron to a tensile strain.

The resistance in tons per square inch of—

Yorkshire Iron is	24·50 tons.
Derbyshire „	20·25 „
Shropshire „	22·50 „
Staffordshire „	20·00 „

Strength of Rivetted Joints.

The architect having fortified himself with the above facts, will be better able to carry out a judicious distribution of the frames, ribs, and plates of an iron ship, so as to meet the various strains to which it may be subjected, and ultimately to arrive at a distribution where the whole in combination presents uniformity of resistance to repeated strains, and the various changes it has to encounter in actual service.

There is, however, another circumstance of deep importance to the naval architect, which should on no account be lost sight of, and that is, the comparative values of the rivetted joints of plates to the plates themselves. These, according to experiment, give the following results:—

Taking the cohesive strength of the plate at	100
The strength of the double-rivetted joint was found to be	70
And the single-rivetted joint	56

These proportions apply with great force to vessels requiring close rivetting, such as ships and boilers that must be water-tight, and in calculation it is necessary to make allowances in that ratio.

Strength of Ships.

Of late years it has been found convenient to increase the length of steamers and sailing vessels to as much as eight or nine times their breadth of beam, and this for two reasons; first, to obtain an increase of speed by giving fine sharp lines to the bow and stern; and second, to secure an increase of capacity for the same midship section, by which the carrying powers of the ship are greatly augmented. Now, there is no serious objection to this increase of length, which may or may not have reached the maximum. But, unfortunately, it has hitherto been accomplished at a great sacrifice to the strength of the ship. Vessels floating on water and subjected to the swell of a rolling sea,—to say nothing of their being stranded or beaten upon the rocks or sand banks of a lee shore,—

are governed by the same laws of transverse strains as simple hollow beams, like the tubes of the Conway and Britannia tubular bridges. Assuming this to be true, and indeed it scarcely requires demonstration, it follows that we cannot lengthen a ship with impunity without adding to her depth or to the sectional area of the plates in the middle along the line of the upper deck.

If we take a vessel of the ordinary construction, or what some years ago was considered the best—300 feet long, 41 feet 6 inches beam, and 26 feet 6 inches deep—we shall be able to show how inadequately she is designed to resist the strains to which she would be subjected. To arrive at these facts we shall approximate nearly to the truth by treating it as a simple beam; and this is actually the case, to some extent, when a vessel is supported at each end by two waves, or when rising on the crest of another, supported at the centre with the stem and stern partially suspended. Now in these positions the ship undergoes, alternately, a strain of compression and of tension along the whole section of the deck, corresponding with equal strains of tension and compression along the section of the keel, the strains being reversed according as the vessel is supported at the ends or the centre. These are, in fact, the alternate strains to which every long vessel is exposed, particularly in seas where the distance between the crests of the waves does not exceed the length of the ship.

It is true that a vessel may continue for a number of voyages to resist the continuous strains to which she is subjected whilst resting on water. But supposing in stress of weather, or from some other cause, she is driven on rocks, with her bow and stern suspended, the probability is that she would break in two, separating from the insufficiency of the deck on the one hand, and the weakness of the hull on the other. This is the great source of weakness in wrought-iron vessels of this construction, as well as of wooden ones, when placed in similar trying circumstances.*

CHANGES IN PROGRESS.

Having directed attention to the strength of ships, and the necessity for their improved construction, we may now advert to the changes by which we are surrounded and to the revolution now pending over the destinies of the navy, and the deadly weapons now forging for its destruction. It is not for us alone, but for all other maritime nations, that these Cyclopean monsters are now issuing from the furnaces of Vulcan; and it behoves all those exposed to such merciless enemies to be upon their guard, and to have their *Warriors*, *Merrimacs*, and *Monitors*, ever ready, clothed in mail from stem to stern to encounter such formidable foes. It has been seen, and every experiment exemplifies the same fact, that the iron ship with its coat of armour is a totally different construction to that of the wooden walls which for centuries have been the pride and glory of the country. Three deckers, like the *Victory* and the *Ville de Paris* of the last century, would not exist an hour against the sea-monsters now coming into use.

The days of our wooden walls are therefore gone; and instead of the gallant bearing of a 100-gun ship, with every inch of canvas set, dashing the spray from her bows and careering merrily over the ocean, we shall find in its place a black demon, some five or six hundred feet long, stealing along with a black funnel and flag-staff on her mission of destruction, and scarcely seen above water, excepting only to show a row of teeth on each side, as formidable as the immense iron carcass that is floating below. This may, with our present impressions, be considered a perspective of the future navy of England,—probably not encouraging,—but one on which the security of the country may ultimately have to depend, and to the construction of which the whole power and skill of the nation should be directed. I have noticed these changes, which are fast approaching, from the conviction that the progress of the applied sciences is not only revolutionizing our habits in the developement of naval constructions, as in every other branch of industry, but the art of war is undergoing the same changes as those which have done so much for the industrial resources of the country in times of peace. It is therefore necessary to prepare for the changes now in progress, and endeavour to effect them on principles calculated, not only to ensure security, but to place this country at the head of constructive art. It is to attain these objects that a long and laborious class of experiments have been undertaken by the Government, to determine how the future navy of England shall be built; how it should be armed; and under what conditions it can best maintain the supremacy of the seas. This question does not exclusively confine itself to armour-plated vessels, but also to the construction of ships which, in every case, should be strong and powerful enough to contend against either winds and waves or to battle with the enemy. It is for these reasons that I have ventured to direct attention to the strength of vessels, and to show that some of our mercantile ships are exceedingly weak, arising probably from causes of a mistaken economy on the one hand, or a deficiency of knowledge or neglect of first principles on the other.

Now, it is evident that our future ships of war of the first class must be long and shallow; moreover they must contain elements of strength and powers of resistance that do not enter into the construction of vessels that are shorter and nearly double the depth. If we take a first-rate ship of the present construction, such as the "Duke of Wellington,' and compare it with one of the new or forthcoming constructions carrying the same weight of ordnance, we should require a vessel nearly twice the length and little more than half her depth. Let us, for example, suppose the *Duke of Wellington* to be 360 feet long and 60 feet deep, and the new construction 500 feet long and 46 feet deep; we should then have for the resistance of the *Duke of Wellington* to a transverse strain tending to break her back,

$$W = \frac{a\,d\,c}{l}$$

* See Vol. 1 of the "Transactions of the Institution of Naval Architects," on the Strength of Iron Ships.

Taking 60 as the constant, and the area of the bottom and upper deck as 1060 square inches, we have

$$W = \frac{1060 \times 60 \times 60}{340} = 12{,}223 \text{ tons},$$

as the weight that would break her in the middle. Let us now take the new ship, and give her the same area top and bottom, and again we have

$$W = \frac{1060 \times 46 \times 60}{500} = 5851 \text{ tons},$$

which is less than half the strength. From this it is obvious—if we are correct in our calculations—that the utmost care and attention is requisite in design and construction to ensure stability and perfect security in the build of ships.

MECHANICAL PROPERTIES OF IRON.

It is unnecessary to give more examples in regard to strength, and the proportions that should be observed in the construction of our future navy. I have simply directed attention to it as a subject of great importance, and one that I am satisfied will receive careful consideration on the part of the Admiralty and the Comptroller of the Navy.

The next question for consideration is, the properties of iron best calculated to resist the penetration of shot at high velocities, and in this I am fortunate in having before me the experiments of the Committee on Iron Plates, which may be enumerated as under:—

Specific Gravity.	Tensile Strength in Tons per Square Inch.	Compression per Unit of Length in Tons.	Statical Resistance to Punching in Tons; 1-inch Plate.
7·7621	24·802	14·203	40·1804

REMARKS.

The specimens subjected to compression gradually squeezed down to one-half their original height, increasing at the same time in diameter till they attained 90 tons on the square inch.

In these experiments, four descriptions of iron were selected, marked A, B, C, D: the two first and last were taken from rolled and hammered iron plates, excepting C, which was homogeneous, and gave higher results to tension and dead pressure than the others.

In density and tenacity they stood as follows:—

Mark on Plates.	Density.	Tenacity in Tons.	Remarks.
A Plates	7·8083	24·644	
B Plates	7·7035	23·354	
C Plates, homogeneous	7·9042	27·032	
D Plates	7·6322	24·171	

Here it will be observed, that the strengths are in the ratio of the densities, excepting only the B plates, which deviate from that law.

On the resistance to compression, it will be seen that in none of the experiments was the specimen actually crushed; but they evidently gave way at a pressure of 13 to 14 tons per square inch, and were considerably cracked and reduced in height by increased pressure.

From the experiments on punching, we derive the resistance of A, B, C, D plates to a flat-ended instrument forced through the plate by dead pressure, as follows:—

Mark on Plates.	Shearing Strain in Tons per Square Inch.	Ratio, taking A as Unity.
A Plates	19·511	1·000
B Plates	17·719	0·907
C Plates	27·704	1·168
D Plates	17·035	0·873

Here may be noticed, that the difference between the steel plates of series C, and the iron plates of series A, is not considerable, though in all the others the steel plates exhibit a superiority in statical resistance.

Having ascertained, by direct experiment, the mechanical resistance of different kinds of iron and steel plates to forces tending to rupture, it is interesting to observe the close relation which exists between not only the chemical analysis as obtained by Dr. Percy, but how nearly they approximate to the force of impact, as exhibited in the experiments with ordnance at Shoeburyness.

Dr. Percy, in his analysis, observes, that of all the plates tested at Shoeburyness, none have been found to resist better than those lettered A, B, C, D, with the exception of C. The iron of plate E contained less phosphorus than either of the three, A, B, D; and it is clearly established that phosphorus is an impurity which tends in a remarkable degree to render the metal "cold short," *i.e.* brittle when cold.

The following table shows the chemical composition of these irons :—

Mark.	Carbon.	Sulphur.	Phosphorus.	Silicon.	Manganese.
A	0·01636	0·104	0·106	0·122	0·28
B	0·03272	0·121	0·173	0·160	0·029
C	0·023	0·190	0·020	0·014	0·110
D	0·0436	0·118	0·228	0·174	0·250
E	0·170	0·0577	0·0894	0·110	0·330

Comparing the chemical analysis with the mechanical properties of the irons experimented upon, we find that the presence of 0·23 per cent. of carbon causes brittleness in the iron; and this was found to be the case in the homogeneous iron plates marked C; and although it was found equal to A plates in its resistance to tension and compression, it was very inferior to the others in resisting concussion or the force of impact. It therefore follows, that toughness combined with tenacity is the description of iron plate best adapted to resist shot at high velocities. It is also found that wrought-iron, which exhibits a fibrous fracture when broken by bending, presents a widely different aspect when suddenly snapped asunder by vibration, or by a sharp blow from a shot. In the former case the fibre is elongated by bending, and becomes developed in the shape of threads as fine as silk, whilst in the latter the fibres are broken short, and exhibit a decidedly crystalline fracture. But in fact, every description of iron is crystalline in the first instance; and these crystals, by every succeeding process of hammering, rolling, &c., become elongated, and resolve themselves into fibres. There is, therefore, a wide difference in the appearance of the fracture of iron when broken by tearing and bending, and when broken by impact, where time is not an element in the force producing rupture.

If we examine with ordinary care the state of our iron manufacture as it existed half a century ago, we shall find that our knowledge of its properties was of a very crude and most imperfect character. We have yet much to learn, but the necessities arising from our position as a nation and the changes by which we are surrounded, will stimulate our exertions to the acquisition of knowledge and the application of science to a more extended investigation of a material destined, in course of time, to become the bulwark of the nation. It is, therefore, of primary importance, that we should make ourselves thoroughly acquainted, not only with the mechanical and chemical properties of iron, but we should moreover be able to apply it in such forms and conditions as are best calculated to meet the requirements of the age in which we live.

Entertaining these views, I cheerfully commenced with my talented colleagues the laborious investigations in which we are now engaged, and looking at the results of the recent experiment with the 300-pounder gun on the one hand, and the resisting targets on the other, there is every prospect of an arduous and long-continued contest.

From the Manchester experiments, to which I have alluded, we find that with plates of different thicknesses, the resistance varies directly as the thickness, that is, if the thickness be as the numbers 1, 2, 3, &c., the resistance will be as 1, 2, 3, &c.; but those obtained by impact at Shoeburyness show, that up to a certain thickness of plate, the resistance to projectiles increases nearly as the square of the thickness. That is, if the thickness be as the numbers 1, 2, 3, 4, &c., the resistance will be as the numbers 1, 4, 9, 16, &c., respectively. The measure, therefore, of the absolute destructive power of shot is its *vis viva*, not its momentum as has been sometimes supposed, but the work accumulated in it varies directly as the weight of the shot multiplied into the square of the velocity.

There is therefore a great difference between statical pressure and dynamical effect; and in order to ascertain the difference between flat-ended and round-ended shot, a series of experiments were undertaken with an instrument or punch exactly similar in size and diameter and precisely corresponding with the steel shot of the wall piece ·85 diameter employed in the experiments at Shoeburyness. The results on the A, B, C, and D plates are shown in the following table.

These figures show that the statical resistance to punching is about the same whether the punch be flat-ended or round-ended, the mean being in the ratio of 1000 : 1085 or 8½ per cent. greater in the round-ended punch. It is, however, widely different, when we consider the depth of indentation of the flat-ended punch and compare it with that produced by the round-ended one, which is 3½ times greater. Hence, we derive this remarkable deduction, that whilst the statical resistance of plates to punching is nearly the same, whatever may be the form of the punch, yet the dynamic resistance or work done in punching is twice as great with a round-ended punch as with a flat-ended one. This of course only approximately expresses the true law; but it exhibits a remarkable coincidence with the results obtained by ordnance at Shoeburyness, and explains

Character of Plates.		Resistance in lbs.	
		Punch Flat-ended.	Punch Round-ended.
Half-inch thick	A Plates	57,956	61,886
	B Plates	57,060	48,788
	C Plates...	71,035	85,524
	D Plates	49,080	43,337
Three-quarter-inch thick	B Plates	84,587	98,420
	D Plates	82,381	98,571
	Mean........................	67,017	72,754

the difference which has been observed in these experiments, more particularl in those instances where round shot was discharged from smooth-bored guns at high velocities. To show more clearly the dynamic effect or work done by the weight of shot which struck some of the targets at different velocities, the following results have been obtained.

Target.	Weight of Shot striking Target; lbs.	Work done on Target.	
		Total Foot lbs.	Per Square Foot. Foot lbs.
Thorneycroft 8-inch Shield	1253	—	29,078,000
Thorneycroft 10-inch Embrasure ...	1511	—	37,140,000
Roberts's Target	946	822,000	19,726,000
Fairbairn's Target........................	1024	324,000	23,311,000
Warrior Target	3229	312,000	62,570,000
The Committee's Target	6410	—	124,098,780

From the above, it will be observed, that the two last targets have sustained in work done what would, if concentrated, be sufficient to sink the largest vessel in the British navy.

We are all acquainted with the appearances and physical character of artillery, but few are conversant with the nature of the operations and the effects produced by shot on the sides of a ship or on resisting forts and targets

The shot of a gun—to use the expression of my colleague, Mr. Pole—is simply the means of transferring mechanical power from one place to another. The gunpowder in the gun developes by its combustion a certain quantity of mechanical force, or work as it is now called, and the object of the shot is to convey this work to a distance, and apply it to an object supposed to be otherwise inaccessible. The effect of this, according to Mr. Pole's formula, is—

W = weight of the shot in lbs.
V = its velocity in feet per second.

Then, by the principle of *vis viva*, the quantity of work stored up by the moving mass, measured in lbs. one foot high, is

$$= \frac{W V^2}{2 g}$$

g being the force of gravity = $32\frac{1}{6}$.

Thus, if we have a shot, like that recently used against the *Warrior* target, 156lbs., moving at the rate of 1700ft. per second, the work done will be—

$$= \frac{156 \times (1700)^2}{64\frac{1}{3}} = 7,008,238 \text{ one foot high.}$$

Showing at once the immense power that this small body is able to deliver on every resisting medium tending to arrest its course and bring its particles to a state of rest. Or, in other words, it is equivalent to raising upwards of 3000 tons a foot high in the air.

The Application of Iron for Purposes of Defence.

Having examined in a very condensed and cursory manner the present state of our knowledge in regard to iron, and its application to the purposes of shipbuilding, let us now consider in what form and under what circumstances it can best be applied for the security of our vessels and forts. To the latter the answer is, make the battery shields thick enough: but a very different solution is required for the navy, where the weight and thickness of the plates is limited to the carrying powers of the ship. It has been observed with some truth that we have learnt a lesson from the recent naval action on the American waters; but it must be borne in mind that neither of the vessels eagaged nor the ordnance employed were at all comparable to what have been used at Shoeburyness.

To those who, like myself, have gone through the whole series of experiments the late engagement will appear instructive, but not calculated to cause any great alarm, nor yet effect any other changes than those primarily contemplated by the Government, and such as have been deduced from our own experiments. It is, nevertheless, quite evident that our future navy must be entirely of iron; and judging from the last experiment with the Armstrong smooth-bore gun, it would almost appear as a problem yet to be solved, whether our ships of war are not as safe without iron armour as with it. If our new construction of ships are strong enough to carry armaments of 300-pounder guns, which is assumed to be the case, our plating of 6 or 7 inches thick would be penetrated, and probably become more destructive to those on board than if left to make a free passage through the ship. In this case we should be exactly in the same position as we were in former days with the wooden walls; but with this difference, that if built of iron the ship would not take fire and might be made shell proof. It is, however, very different with forts, where weight is not a consideration, and those I am persuaded may be made sufficiently strong to resist the heaviest ordnance that can be brought to bear against them. In this statement I do not mean to say that ships of war should not be protected; but we have yet to learn in what form this protection can be effected to resist the powerful pieces of ordnance, and others of still greater force which are looming in the distance, and are sure to follow.

A great outcry has been raised about the inutility of forts; and the Government, in compliance with the general wish, has suspended those at Spithead: I think improperly so, as the recent experiments at Shoeburyness clearly demonstrate that no vessel, however well protected by armour-plates, could resist the effects of such powerful artillery; and instead of the contest between the *Merrimac* and the *Monitor*, and that of the 300-pounder gun being against, they are to every appearance in favour of forts. Should this be correct, we have now to consider how we are to meet and how resist the smashing force of such powerful ordnance as was levelled against the *Warrior* target.

During the whole of the experiments at Shoeburyness I have most intently watched the effects of shot on iron plates. Every description of form and quality of iron has been tried, and the results are still far from satisfactory; and this is the more apparent since the introduction of the large 300-pounder, just at a time when our previous experiments were fairly on the balance with the 40, 68, 100, and 126-pounders. They now appear worthless, and nothing is left but to begin our labours again *de novo*.

It has been a question of great importance, after having determined the law of resistance and the requisite quality of the iron to be used as armour plates, how these plates should be supported and attached to the sides of the ship. Great difference of opinion continues to exist on this subject,—some are for entirely dispensing with wood; probably the greater number contend for a wood backing, the same as the *Warrior* and the *Black Prince*. I confess myself in the minority on this question; and, judging from the experiments, I am inclined to believe from past experience that wood combined with iron is inferior to iron and iron in its power of resistance to shot; and I am fully persuaded that ultimately the iron armour plates must be firmly attached to the side, technically called the skin, of the ship. It must, moreover, form part of the ship itself, and be so arranged and jointed as to give security and stability to the structure.

The experiments instituted by the Committee on Iron Plates have been well considered and carefully conducted; they commenced with a series of plates selected from different makers of varying thicknesses, and these have been tested both as respects quality and their powers of resistance to shot. They have moreover, been placed at different angles and in a variety of positions, and we had just arrived at the desired point of security, when the thundering 300-pounder smooth bore upset our calculations and levelled the whole fabric with the ground. We are, however, not yet defeated; and true to the national character, we shall, like the knights of old, resist to the last—

"And though our legs are smitten off,
We'll fight upon our stumps."

And thus it will be with the Iron Committee and the Armstrong and the Whitworth guns.

In conclusion, allow me to direct attention to a drawing of the *Warrior* target, with wood backing and its compeer entirely of iron. The first underwent a severe battering, previous to the attack from the 300-pounder, but the other sustained still greater, with less injury to the plates, notwithstanding the failure of the bolts in the first experiment. It must, however, be admitted that plates on wood backing have certain advantages in softening the blow, but this is done at the expense of the plate, which is much more deflected and driven into the wood, which, from its compressibility, presents a feeble support to the force of impact. Again, with wood intervening between the ship and the iron plates it is impossible to unite them with long bolts so as to impart additional strength to it; on the contrary, they hang as a dead weight on her sides, with a constant tendency to tear her to pieces. Now, with iron on iron we arrive at very different and superior results. In the latter, the armour-plates, if properly applied, will constitute the strength and safety of the structure; and, notwithstanding the increased vibration arising from the force of impact of heavy shot, we are more secure in the invulnerability of the plates, and the superior resistance which they present to the attack of the enemy's guns. In these remarks I must not, however, attempt to defend iron constructions where they are not defensible, and I am bound to state that in constructions exclusively of iron there is a source of danger which it is only fair to notice, and that is, that the result of two or more heavy shot, or a well concentrated fire, might not only penetrate the plates but break the ribs of the ship. This occurred in the last experiment on my own target, where a salvo of six guns concentrated four on one spot, not more than 14in. diameter, went through the plates and carried away a part of the frame behind. The same effect might have taken place on the *Warrior* target; and certainly 9in. of wood is of little value when assailed by a powerful battery of heavy ordnance and a well concentrated fire.*

In closing these remarks, I have every confidence that the skill and energy of this country will keep us in advance of all competitors, and that a few more years will exhibit to the world the iron navy of England, as of old with its wooden walls, unconquerable on every sea.

Obituary.

MR. JAMES MELROSE.

We regret to have to record the death, on the 12th of July last, of Mr. James Melrose, foreman of the Steam Factory at her Majesty's dockyard, Keyham. The deceased was well known and much respected in the Royal Navy.

Mr. Melrose was respectably connected, having sprung from a family of millwrights and engineers, who have been located in Hawick, Scotland, for upwards of a century. Not far from the same locality came Thomas Telford and John Rennie.

At the time when Mr. Melrose was serving his apprenticeship, the extensive works in land and marine engineering were only in their infancy, and the workman of that day had to make himself, in every sense of the word, thoroughly useful. The splendid tools and other appliances which make engineering of the present day so easy were not then known, and the practical engineer had then to get over mechanical difficulties in such ways and means as would astonish the youths of the present time.

At the age of twenty-two, Mr. Melrose left his father's factory, and was employed by Mr. W. Fairbairn, of Manchester; from thence he went with Mr. George Stephenson, to assist in the construction of the celebrated *Rocket*. Mr. Melrose was a great favourite with Stephenson; and at that time both of them used to work at night in making alterations preparatory to the final trials which led to the ultimate success of the *Rocket*. He used to speak of the inquisitive curiosity of William Gladstone, now the celebrated Chancellor of the Exchequer; how he used to come about the *Rocket*, and take a warm interest in its progress, and attend on its experimental trips, to see how the alterations would succeed.

Shortly after this period he was appointed by Mr. James Wilson (late Financial Secretary for India) to travel over the United Kingdom, to get up statistics of the flax spinning and other machinery in this country. Having performed this mission in a very satisfactory manner, he took employment as a millwright in Dundee for a short period, and again returned home to assist his father in the construction of a large woollen factory in one of the neighbouring towns.

In 1836 he went to the Royal Dockyard at Chatham, and in 1840, when the steam factory at Woolwich was opened, he was transferred to that establishment to take charge of the millwright and pattern-making department. In all that is connected with the rapid progress and development of that establishment Mr. Melrose was intimately associated.

In 1854 he was transferred to Keyham, and appointed foreman of the factory at that yard. Those only who know the extent and magnitude of the works at Keyham can fully appreciate the value of Mr. Melrose as an engineer—the amount of thought, labour, and energy which he expended on these works, though in a subordinate capacity; and we feel certain that the late respected chief engineer of Keyham would fully bear out our remarks. During the years 1854-55 and part of 1856, in addition to his usual duties, extraordinary exertions had to be made in the factories, to meet the requirements of the steam navy, during the war. Again, in 1859-60, exertions even greater were required to reconstruct the steam navy.

The duties devolving on the practical officers of the factories are untiring and continuous. Mr. Melrose was energetic and devoted, and so thoroughly conscientious, that he was always at his post. The long hours, the great amount of mental as well as physical labour involved, combined with irregularity of diet, &c., acting on a frame not very robust, brought on disease, which, after a few weeks' severe suffering, ended in death on the 12th of July last, in his native town, where he had gone to try change of air. By his premature death (at the age of fifty-two) the public service has lost a most valuable officer, his family a loved husband and father, and a large circle of friends and acquaintances one who was esteemed in proportion as he was known.

We can only express our regret that one so fully entitled, both from long servitude as well as from the extent and value of his acquirements as an engineer officer, should have remained so long in a subordinate capacity; and still more is it to be regretted that the last months of his life were darkened by one of those strange freaks of a public department, by which subordinate officers in the factories were excluded for ever from rising to a higher position, however valuable their requirements, if they were over thirty-five years of age; and young men of mathematical acquirements placed over them as their superiors. We say, such strange experiments do not promise well for the future efficiency of the public service.

* Since the above was was written, another experiment has been made on the *Warrior* target with the 300-pounder smooth-bore gun. From this it appears that the wood backing between the armour plates and the skin of the ship cannot safely be dispensed with, and that some compressible or softer substance than iron and iron is necessary to deaden the blow, and absorb the fragments of the shot and the broken plates, which in this instance lodged in the wood, and did not perforate, but only cracked, the skin of the target. From this fact it cannot be denied that this experiment is more satisfactory than those on the iron on iron targets; and however desirable it may be to realise a more effective construction as regards the strength of the ship, it cannot be doubted in so far as the security of the ship and the lives of those on board are concerned, that a vessel with wood backing is safer in action than one composed entirely of iron. In the present state of our knowledge the experiments are therefore against iron and iron, as regards security from the effects of shot, but they are unfavourable as respects the strength of the ship.

GRAHAM'S PATENT DOUBLE-ACTING FORCE OR LIFT PUMP, APPLICABLE ALSO AS A FIRE ENGINE.

Our attention has been more especially drawn to the arrangement of Mr. J. Graham's pumps in connection with the recent disaster, in the River Thames, to the iron ship *Ganges*, when these pumps worked so very efficiently in pumping out the water from this vessel after she had been lifted.

We anticipate that, more especially from the excellent valvular arrangement adopted by Mr. Graham, in addition to their great value as pumps for ships' use, from the large volume of water which they are capable of dispersing without deranging the valves, these pumps, applied to fire-engines, and more especially *steam* fire-engines, will be found of very great value, when it is considered that so many of the accidents which have occurred to fire-engines have arisen through defective arrangements of the valves.

Mr. Graham's double-acting force or lift pump, has two chambers with two buckets or plungers working in each chamber; and the rod of the bottom bucket or plunger in each chamber works through an orifice in the upper bucket or plunger made water-tight by means of a moveable brass packing, so as to allow the rod to work in it without a parallel motion. Motion is given to the buckets in each chamber, so that when the one is ascending, the other is descending, the upper bucket moving up and down in the upper end of the chamber, and the lower bucket up and down in the lower end of the chamber, meeting or nearly so in the middle of the chamber. At the side of each chamber, or connected with it, is formed an auxiliary chamber or suction pipe, with a suction valve at the bottom of it for admitting water during the ascent of the upper bucket, the water being admitted through a suction valve at the bottom of the working chamber during the ascent of the lower bucket, and when one of the valves for admitting water is open the other is closed. The water raised by the lower bucket of each pump is forced through an opening furnished with a valve into a reservoir placed between the working chambers, or in any convenient position, and the water raised by each of the upper buckets passes over the top of the working chamber into the same reservoir, from whence the water is forced through the discharge opening. One of the chief advantages in this arrangement is, that when the pump is worked, the one or the other of the buckets in each chamber is always in action, and raising water, and that the quantity of water raised in each chamber of the pump double or much greater than that which is lifted by a single acting pump.

REVIEWS AND NOTICES OF NEW BOOKS.

A Treatise on Ventilation, Natural and Artificial. By Robt. Ritchie, C.E. London: Lockwood and Co. 1862.

Mr. Ritchie is already favourably known, and the present Treatise on Ventilation will be found to be exceedingly useful as a book of reference by those interested in the subject of ventilation, whether applied to public or private buildings, mines, or ships.

The Author describes most of the plans in use, and the several machines and contrivances for effecting ventilation under various circumstances.

A Treatise on Military Drawing and Surveying. With a Course of Progressive Plates. By Capt. W. Paterson, Professor of Military Drawing at the Royal Military College, Sandhurst. London: Trubner and Co., Paternoster Row. 1862.

We referred last month to this valuable work; since which we have had time to make a thorough digest of its contents.

Captain Paterson has rendered a good service in aid of military education, as the present work must prove of great value in enabling officers and candidates for the army to become readily and thoroughly acquainted with the elementary parts of the subjects of military drawing and surveying.

The contents are classified as follows, viz.:—Military Drawing, Military Surveying, Surveying without Reconnaisances, and Miscellaneous Instructions.

Twenty-four plates, admirably drawn on stone, illustrate the subjects treated by Captain Paterson. The work is got up in a highly creditable manner.

Formulæ, Rules, and Examples for Candidates for the Military, Naval, and Civil Service Examinations; also for Mathematical Students and Engineers. By T. Baker, C.E.—Division I.

Iron Work.—*Practical Formulæ and General Rules for Finding the Strain and Breaking Weight of Wrought Iron Bridges. With Useful Tables.* By Charles Hutton Dowling, C.E. London: John Weale. 1862.—Division II.

The contents of the first portion of this book are arranged alphabetically, beginning with aeronautics, and concluding with the definition of *work*, to which are devoted about 176 pages. In addition to which, an appendix is given, containing a collection of examples taken from recent examination papers, &c.

Mr. Dowling's portion of the work consists of only 29 pages, about one-third of which are devoted to tables of weights and strengths; as also measures of capacity. These tables give the French equivalents for English measurements and quantities.

Although most of the information can be found elsewhere, it is here collected in a very handy form for reference.

The Engineers', Millwrights', and Machinists' Assistant. Comprising a Collection of useful Tables, Rules, and Data. By William Templeton. London: Lockwood and Co. 1862.

The Author after an absence of ten years from England, has published another edition of his well-known book, and has introduced numerous additions and improvements, which will be found of value by the practical mechanic.

The Annual Retrospect of Engineering and Architecture; a Record of Progress in the Sciences of Civil, Military, and Naval Construction. Vol. I., January to December, 1861. Edited by George R. Burnell, C.E., F.G.S., F.S.A. London: Lockwood and Co. 1862.

Mr. Burnell has here collected together a vast number of interesting facts and statements—obtained from various sources—connected with engineering, architecture, &c., during the past year; but there is still room for much improvement —in the selection of the matter as well as in its treatment—which we hope to see effected in the vol. for 1862; and we know of no one more capable of collecting such information and succinctly recording the progress of science than Mr. Burnell.

Considérations Générales sur la Cause rationnelle des Marées et des Courants. par le Colonel Bordone. Genoa: 1862.

In this pamphlet Colonel Bordone draws up a sketch of his theory of the causes of the tides and fluctuations in the sea, and more particularly of the origin of the Gulf Stream. The latter phenomenon is explained by the Author as being derived from the transmission of the differential pressures of the atmosphere in the various parts of the ocean. He thus extends to oceanic currents the general physical law of oscillations. Colonel Bordone's views are based upon the observations made by the Brothers Schlagintweit, Dr. Barth, von Tschudi, and other travellers; and we recommend a careful perusal of Colonel Bordone's work to those of our readers interested in the important phenomenon which is so ably treated by the Author in the pamphlet before us.

NOTICES TO CORRESPONDENTS.

C. J. M. E. (London).—The following are the particulars and dimensions of the iron paddle steamer *Douglas*, built by Messrs. Rob. Napier and Sons, Govan, launched April 27th, 1862.

Customs Measurement.	Feet.
Length	213·3
Breadth	26·2
Depth	13·45
Engine-room (length)	42·0
Tonnage.	**Tons.**
Under deck	453·55
Break	36·96
House on break	5·97
Gross	496·48
Engine-room	183·70
Register	312·78

Two side lever engines of 262 horse-power (nominal), cylinders 60in. by 5ft. stroke. No bowsprit, figure-head, or galleries. Round sterned, two masts, schooner-rigged. Sailed from Glasgow 16th June, 1858.

J. W.—The floating docks to which you refer will be found illustrated and described in The Artizan Vols. for 1856 and 1861.

J. P. (Clydach, Swansea).—We have received your communication, and have acquainted the Hon. Sec. with your name and address, in order that he may forward you that which you require. We have not the paper in our own possession.

S. J.—You will find the explanation of, and also illustration of, the machine to which you refer, in No. 2 of The Artizan Exhibition Supplementary Series.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

The Petroleum Question.—Indictment of a Liverpool Merchant.—At the Liverpool Assizes, on Saturday, the following case came on in connection with the petroleum question:—John Bigham, described as a Liverpool merchant, appeared to answer an indictment charging him with causing a serious nuisance and injury to the public health of Liverpool by the storage of petroleum. Mr. Russell, who appeared for Mr. Bigham, said that there was no less than 70 witnesses named on the back of the indictment, and that he was not prepared to meet the case at the present assizes. He asked, therefore, for a postponement until the winter court. Mr. Littler, who appeared for the prosecution, said that if the case was postponed a great deal of mischief and inconvenience might be created. The nuisance was so great that for the extent of a mile the health and comfort of the inhabitants in the vicinity where the petroleum was stored were greatly interfered with, and the smell was so nauseous that even horses lost their appetite in consequence. Besides, there was also a danger from the explosive quality of the oil On the other hand, Mr. Russell contended that the offensive smell did not arise from the storing, but from the manufacture of the oil, and that, though the process of manufacture was conducted near the defendant's premises, he had no personal interest or control over it. Mr. Liddell, Q.C. (who sat as judge), retired for a few moments to consult Mr. Justice Mellor, and on his return intimated that he should call upon Mr. Bigham to enter into recognisances to appear at the next assizes. In the meantime, however, should any serious or special damage arise from the storage of the oil, the defendant would be held responsible. Mr. Bigham was then formally bound over to appear, or forfeit £500.

GOSLING AND WIFE *v.* THE LONDON, BRIGHTON, AND SOUTH COAST RAILWAY.—The plaintiff in this action is a grocer at Three Bridges, and he sought to recover damages for injuries sustained by his wife, owing, as was alleged, to the defendants having im properly left a mass of chalk in a road leading to the Hayward's Heath Station, through which a vehicle in which she was driven was overturned. The defendants pleaded that the road in question was a private road, where the public had no right to go, and whether it was so or not was the only question in the cause, a number of witnesses being called on behalf of the plaintiff to show that the road in question had been constantly used by them and other persons without any objection being made by the company, while the case of the latter was that the road was their private property. Baron Martin, in summing up the case, ruled that, although the road in question might in point of fact be private, still, if the company allowed the public to use it, they were bound to take care that it was not left in a condition whereby an accident might be occasioned. The jury returned a verdict for the plaintiff. Damages £110.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts (for which we are chiefly indebted to the *Chemical News*), Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

HARDENING STONE.—Messrs. Jesse, Rust, and Co., of the Lambeth Glass Works, state that they have discovered a simple method, by means of a single solution, containing silica, lime, alumina, and potash, of indurating soft stone to an extent greater and more complete than has yet been otherwise attained. Caen stone they speak of polishing like marble for interior work, after induration. The composition forms a hard, tough, insoluble mass, a glass cement or glass concrete in fact, in the pores of the stone, and may be brushed in effectually by a child, without any attention to chemical quantities, double decompositions, &c.

THE BUTTERLY COMPANY'S CODNOR PARK IRON WORKS near Alfreton, Derbyshire, have recently rolled one of the largest wrought-iron plates ever made. Its dimensions are 42ft. long by 7ft. 2in. wide in the middle, and 4ft. 10in. at the ends by 2in. thick, containing 252 superficial feet, and weighing 9 tons. The largest plate in the Exhibition is from these works, containing 163 square feet, being 89ft. less than the above. The process of heating and rolling this giant plate has been successfully executed. Two of these plates are now rolled; they are for a beam pumping engine of 84-inch cylinder, 10ft. stroke and upwards of 300 horse power, which is being manufactured at the Butterly Iron Works, near Alfreton, for the Clay Cross Colliery Company.

FIRE ENGINES.—A committee of ten gentlemen, including the Duke of Sutherland and the Earl of Caithness, has been formed for the purpose of raising a fund for the offer of prizes for the most efficient steam fire engines, hoping that by thus inducing competition a great improvement upon anything yet invented will be obtained. They likewise ask for the co-operation of insurance companies and parochial authorities. The following constitute the full committee of the above society:—Duke of Sutherland, Earl Caithness, J. G. Appoed, J. F. Bateman, W. M. Brown, T. R. Crampton, J. E. McConnell, J. Nasmyth, W. Smith, C.E., E. M. Shaw, Hon. Sec.

WITHERNSEA NEW LIFE BOAT.—A large and fine new life boat, mounted on her transporting carriage, was forwarded on the 20th ult. by the Royal National Life-boat Institution to Withernsea, near Hull, a dangerous point on the Yorkshire coast. The boat is 34 feet long, 7 feet wide, and rows six oars single-banked, or twelve oars double-banked. Her self-righting qualities were fully and satisfactorily tested on Saturday last, in the Regent's Canal Dock, Limehouse. The water she shipped was self-ejected in 20 seconds. The boat was built by the Messrs. Forrest, of Limehouse. The transporting carriage of the boat, which was built by Mr. J. Robinson, of Kentish Town, was also tried on the occasion, and was found to answer admirably. By an ingenious contrivance the boat, with her crew on board, is launched off the carriage. With their oars in hand they are thus enabled to obtain headway before the breakers have time to beat the boat broadside on the beach. The hauling up of the boat on her carriage is accomplished with equal facility. A commodious and substantial house has been built, from a design furnished by C. H. Cook, Esq., honorary architect to the society, for the reception of the lifeboat, her stores, and carriages. The cost (£300) of the life boat and carriage was presented to the institution by Miss Lechmere, a benevolent lady residing in Worcestershire. Richard Champneys, jun., Esq., the chairman of the branch, has rendered the institution valuable assistance in establishing this life boat station. A grand demonstration took place at Withernsea on Monday, the 25th ult., to inaugurate this important and benevolent gift to the town. The National Life Boat Institution has now 122 life boats in connection with it. Of these nine are stationed on the Yorkshire coast—namely, at Middlesborough, Redcar, Saltburn, Whitby, Scarborough, Filey, Bridlington, Hornsea, and Withernsea.

LIFE-BOATS IN LIVERPOOL.—A meeting has been held at the Rooms of the Royal Mersey Club, to promote the formation of a local branch at Liverpool of the Royal National Life-boat Institution. Letters were read fram a number of influential gentlemen, offering their services on the committee, and to give support to the project. Some of the most influential residents in Liverpool have been elected members of the local committee. In the course of a conversation it was mentioned that the inspector of life-boats to the institution had strongly recommended the erection of a station at the entrance of the Mersey, and that the committee of the institution, if a local branch were formed at Liverpol, were prepared to carry out the recommendation.

SERKIS BALLIAN'S ROTATORY ENGINE.—For the first number of the ARTIZAN Exhibition Supplementary Series we illustrated and described Mr. Serkin Ballian's Rotary Engine, as exhibited in the Turkish department of the International Exhibition, being a practical example of the successful application of the principle of driving the main shaft through the direct action of the piston. We now understand that the inventor is constructing a rotary engine of the same description of from 80 to 100 horse-power; and a trial, we have no doubt, will prove whether rotary engines of Mr. Ballian's construction will, as stated by the inventor, be of equal value in practical utility to the direct acting engines at present in use. We hear that the Sultan has awarded to M. Ballian the sum of 100,000 piasters and the Cross of the Medjhidjat Order for his invention.

INSTANTANEOUS STEAM GENERATOR.—An improved steam generator, constructed on the principle of injecting a small quantity of water on a heated metallic surface, thereby flashing it into steam, has been invented by Mr. R. Rafael, of New York. U.S. The first thing to be accomplished is the almost instantaneous evaporation of the water injected at every stroke of the piston, avoiding the sudden pressure which is created when there is too great a difference between the temperature of the water thus injected and that of the surfaces against which it impinges, and which is particularly dangerous when the capacity of the vessel is very small. But if the water on entering the vessel comes in contact with surfaces of a temperature comparatively low, and thus has its own temperature gradually raised by contact with these surfaces until it comes in contact with those that are hottest, it will already be in the form of very hot steam. In order to relieve the generator, and to prevent the accumulation in it of very great pressure, the communication with the engine cylinder is opened at the moment of injecting the water, and thus the pressure is exerted against the piston of the engine. Suppose the generator to consist of the ordinary spiril coil placed vertically upon the furnace. The lower turn will be the hottest, and every succeeding one will have less temperature as they recede from the fire, the difference being very considerable between the lowest and the highest turns. Indeed, this difference in the temperature of the different turns of the coil may be regulated at pleasure, by giving them any desired distance between each other. Now, instead of injecting the water in the lowest part of it, which is the hottest, and causing the steam to ascend and issue from the apparatus through the highest part of it, which is the coldest, the water is to be injected in the highest part, which being heated to a moderate degree is most favourable for its rapid evaporation and conversion into steam; it is caused to descend towards the furnace, and come successively in contact with surfaces heated to higher temperatures, each higher than the previous one, thus gradually superheating itself in its passage downwards, until at the moment of issuing from the apparatus through the opening at the lowest part of it has acquired the highest possible degree of heat. As the communication between the generator and the cylinder of the engine opens at the moment of the injection of the water into the generator, the steam formed would lose a great part of its temperature, and therefore, of its elastic force, by the expansion thus suddenly opened to it, if this loss of temperature were not made good by the superheating above described, it being impossible for any particle of the steam generated to enter into the cylinder of the engine without sweeping the whole superheating distance above described. The downward current of steam prevents the deposit of any sediment, and the formation of incrustations. Substances held in solution in the water when separated from it by its evaporation in ordinary boilers descend by their own gravity, and accumulate mostly in the lowest part of the boiler or steam generator. But in the improved generator the rapid downward current of the steam coinciding with the natural tendency of the particles that would form deposit, prevent by necessity its formation. The water when injected is divided into minute particles, each one of which, by falling upon a distinct portion of the heated metallic surface is acted upon by the heat contained in it, and converted speedily into steam. To accomplish this, the water enters a long metallic tube of small diameter almost closed at the end, and which for the length of about 12 or 14in., according to the size of the generator, is perforated with very small holes placed at some distance apart from each other. This tube is introduced into a larger tube, forming the upper end of the generator, leaving an annular space between the outside of the inner tube and the inside of the outer tube. At the mouth of the outer tube this space is closed so as to make it steam-tight, and then the inner tube is connected with the feed-pump. The length of the stroke of this pump being regulated, so that the required quantity of water will be thrown in at every stroke and no more, and the generator being brought to a convenient degree of heat, the pump is put in operation, forcing the required quantity of water up the inner tube, and through the small apertures before mentioned, forcing it in drops or very thin jets on the inner surface of the outer tube. It appears that the essential features of novelty in the present invention are gradual heating of the water by causing it to come successively in contact with metallic surfaces heated to different degrees of temperature, each succeeding one that the water comes in contact with being hotter than the one which it had just left, thus causing a gradual and easy change, and the same time a rapid one from cold water to highly superheated steam, for the purposes above set forth, whether the surfaces so heated at different degrees are continuous as in a spiral or in any other form—the imparting of an inverted or downward current to the water and steam, whereby their gradual heating is accomplished in a more easy, natural, and perfect manner, and all sediments are carried away, so that the apparatus when in the form of a spiral coil is kept clean and free from incrustations, the introduction of the water into the apparatus, whether in a spiral or any other form, at a point at or near the top, and the issue of the steam from it at a point at or near the bottom, whether the apparatus contains or not any chest or reservoir for steam, for the purposes before set forth, the use of a rectilinear form of the circuit for these purposes—the use of small perforated tubes enclosed concentrically within other tubes, or enclosed between the plates of the circuit—the attachment of the generator to air, or other thermo-dynamic engines for the purpose of increasing their power, and the introduction of steam as an auxiliary power into caloric or air-engines, the steam being produced or acted upon by the same fire of the engines.

COMBUSTIBILITY OF PETROLEUM.—Much discussion and diversity of opinion having recently obtained in Liverpool, regarding the risk of storing the petroleum now arriving there, some experiments were made recently with a view to test the inflammability of the liquid. The experiments, undertaken at the instance of the Watch Committee of the corporation, were superintended by Major Greig, the head constable. Five thirty-gallon barrels of crude petroleum, or rock oil from Canada, and also from Philadelphia, were burnt under different circumstances. In every case the combustion was rapid and fierce. In two of the experiments made in a confined chamber built for the purpose, Phillip's fire annihilators extinguished the fire in a few minutes. In another, in the same chamber, water thrown on the burning mass by two hose extinguished the fire with considerable rapidity. Two barrels were ignited in the open air, one after the other. In the first a fire annihilator, which was brought to bear on it partially, was thrown out of the conductor's hand, he himself was knocked down, and many of the crowd were overthrown in their anxiety to escape from the supposed danger. The water hose were then brought to bear on the burning mass, and they soon overcame the flames, which were afterwards several times rekindled and re-extinguished. So far as the experiment referred to can be held to be a criterion, petroleum seems to burn in much the same manner as to intensity and rapidity as turpentine, to which in combustion it bears a strong resemblance, and not to be much more combustible than whisky, rum, or brandy. As few, if any, of the ordinary conditions of a fire were present at these experiments, it is a matter of doubt how far they establish any theory which has been propounded for or against rock oil as a dangerous article, or, at all events, as a more dangerous article of commerce than several others which we are in the habit of storing and using daily.

NAVAL ENGINEERING.

Naval Appointments.—The following appointments have taken place since our last: —E. J. Burnley, Chief Engineer, to the *Himalaya;* H. Johnson, First-class Assist. Engineer, to the *Vindictive;* J. Fraser, Acting Second-class Assist. Engineer, to the *Black Prince;* C. Cresswell, W. Onwins, J. Walker (A), and J. G. Barrow, promoted to Acting Engineers; W. H. Greene, J. Downe, R. Mockett, J. Walsh, and J. Ferguson, promoted to Engineers; W. Williamson, Engineer, to the *Indus*, for the *Porpoise;* J. Rothery, Engineer, to the *Racehorse;* W. Young, First-class Assist. Engineer, to the *Rattler;* J. Scott (A), Acting First-class Assist. Engineer, to the *Pembroke;* J. A. Rowe, Acting Second-class Assist. Engineer, to the *Indus*, for the *Leopard;* W. A. Dinnen, promoted to be inspector of machinery afloat, and appointed to the *Indus*, for the steam reserve, vice Steil; W. Austin, Chief Engineer, to the *Asia*, for the *Mersey;* T. H. Symons, Chief Engineer, to the *Himalaya*, vice Burnely; J. Snell, Engineer, to the *Asia* as supernumerary; B. F. Pine, Engineer, to the *Indus*, for the *Royalist;* P. Robertson, Acting First-class Assist. Engineer, to the *Edgar*, vice Woodfield; A. Dewar, Acting Second-class Assist. Engineer, to the *Edgar*, vice Blanch; J. Brown, Chief Engineer, to the *Asia*, for the *Prince of Wales;* J. Barnett, Supernumerary, promoted to Acting First-class Assist. Engineer; J. Conway and J. Miller, confirmed as Second-class Assist. Engineers, in the *Plover* and *Jason*, respectively; F. J. Taplin, Engineer; W. H. Roberts, First-class Assist. Engineer; and J. B. Firth and D. M'Intyre, Second-class Assist. Engineers, to the *Argus;* E. C. Spencer, confirmed as First-class Assist. Engineer, in the *Severn;* B. R. King and J. Hall, Acting Second-class Assist. Engineers to the *Industry* and *Cornwallis*, respectively; J. McIntosh and J. Hawkings, Acting Second-class Assist. Engineers, to the *Cumberland;* T. Lewis, in the *Ranger*, prompted to Acting Engineer; T. A. Clarke promoted to Acting Chief Engineer, in the *Procris;* J. Bell (A), Second-class Assist. Engineer, to the *Liffey;* G. Griffiths, Engineer, qualified for charge, to the *Asia*, for the *Enchantress;* J. Craven, Acting First-class Assist. Engineer, to the *Shannon*, vice Bacon; P. Wood, Chief Engineer; F. Wheeler and F. C. Ford, First-class Assist. Engineers; E. Last, Second-class Assist. Engineer, and J. Fawcett, Acting Second-class Assist. Engineer, to the *Rattlesnake;* T. Marsden, Acting First-class Assist. Engineer, to the *Indus*, for the *Partridge;* A. Kennedy, Second-class Assist. Engineer, to the *Virago;* J. Frazer, Second-class Assist. Engineer, to the *Indus*, for hospital treatment; W. G. Starling, in the *Cornwallis;* and G. Elliott, in the *Indus*, confirmed as Second-class Assist. Engineers; F. Moore, W. J. Sprake, W. B. Cleverly, and H. Rawlings, Acting Second-class Assist. Engineers, to the *Asia*, as Supernumeraries; H. J. Bailiffe, in the *Megæra;* and O. L. Carlisle, in the *Asia*, promoted to the rank of Engineers.

The "Dasher," paddle-wheel steamer, tested her boilers and machinery at the measured mile at Stokes Bay, on the completion of her repairs at Portsmouth Dockyard. The six runs were made with full power, with the following result in knots;—9·524 7·982, 9·574, 7·982, 9·625, 8·163, the mean of the whole being 8·795. With four runs at half-boiler power the average was 7·361 knots. The revolutions of the engines were from 24 to 25 at full power, and from 19 to 20 at half power. The pressure of steam was 10lb., and the vacuum 25 and 27 inches. In making the circle the one to starboard was made in 2 min. 53 sec., the angle of the rudder being 33 deg., and the half circle occupied 1 min. 23 sec. To port, the full circle occupied 2 min. 58 sec., the angle of the rudder being 35 deg., and the half circle 1 min. 29 sec. The revolutions of the engines were 20·5. The *Dasher* is of 260 tons burden, was built at Chatham in 1837, and is fitted with engines of 100 horse-power nominal.

Armour-plated Cupola Vessel of War.—The Board of Admiralty has fully approved the model of an improved armour-plated cupola vessel, invented by Mr. Turner, master shipwright at the Woolwich Dockyard, and one of these vessels is ordered to be constructed. The iron cupola will be fixed instead of movable, 200ft. long, 50ft. broad, and 10ft. deep. Guns will be placed round the vessel from fore to aft, and will be able to sweep the water at such a depression that no gun vessel can approach. She will be fitted with a ram 3ft. under the surface of the water, 8ft. long, and her rudder tiller and propeller will be under water. The vessel will carry 26 guns, and her dimensions will be 330ft. long, 64ft. broad, 25ft. draught, and 8700 tons of displacement.

The "Rattler," screw steam sloop, was taken from her moorings on the 30th of July, for the trial of her machinery at the measured mile. The machinery, which was built by Messrs. Maudslay, Son, and Field, was in the charge of the manager to the firm. The vessel is fitted with double-piston rod direct-acting horizontal engines, of 200 nominal and 800 indicated horse-power. Her average speed, with full boiler power, was 10·00 knots per hour; her average number sf revolutions, 88; her pressure of steam, 20lb.; her vacuum, 23; and at half-boiler power her average speed was 7·692 knots per hour. She turned the half circle in 2 min. 38 sec.; the full circle in 5 min.; was stopped in 10 sec.; turned astern in 20 sec.; and turned easy ahead in 5 sec. She carries a Griffiths' screw, with a pitch of 14ft. and a diameter of 12ft.; her draught of water was 14ft. 3in., both fore and aft.

The "Racoon," 22, 400 horse-power, was on the 29th of July taken on her second trial trip from Chatham Harbour, as far as the Maplin Land, for the purpose of testing her machinery, when the trial was considered far more satisfactory, the vessel attaining a speed of more than a knot an hour over her previous trial.

The "Rattler."—Notwithstanding the very successful trial on the 30th July, of the machinery erected by Messrs. Maudslay, Sons, and Field, in Her Majesty's ship *Rattler*, 17, screw steam sloop, 200-horse power, it was considered by the contractors that the results would be still more satisfactory if the funnels were lengthened and the corners of the screw cut off. Accordingly, the necessary alterations having been made, the vessel was again taken to the measured mile off Maplin Sands, in charge of Capt. T. P. Thompson, of the steam reserve, to test the results on the 8th ult. The ship had a draught of water of 14ft. 4in. forward, and 14ft. 10in. aft., and the force of wind (W.S.W.) was 6 and upwards during the trial. The average speed of 10 knots per hour was attained, the wind and tide being against the vessel throughout the trial. The average revolutions were 89; pressure of steam, 20lb.; and vacuum, 23. The alterations to the funnels and screw have fully answered the end contemplated. The boilers kept steam well, and the working of the machinery was most satisfactory. Mr. Warrener represented the contractors, and had charge of the engine, and Messrs. Blaxland and Urquhart, attended to watch the results for the Admiralty.

The "Royal Oak."—The works which have been for some time in progress at Chatham dockyard for enlarging the entrance to No. 3 dock by the removal of the granite sill and the other projections, so as to allow of the armour plated frigate *Royal Oak*, 51, being placed in that dock as soon as launched, were completed on the 9th ult. The sides of the dock at the entrance have been cut away to the extent of several feet, which will enable the armour plated vessel to be floated in to her place on the blocks with 17 inches to spare on each side. Every exertion is now being used to push the *Royal Oak* forward, to accomplish which there are more than 600 mechanics—shipwrights and other hands—employed on her. As far as the shipwright department is concerned the frigate was ready for launching some time since, but it was decided that she should not be sent afloat until a portion of her armour plates had been affixed to her sides, to accomplish which the efforts of the hands employed about her have been directed. Two tiers of plates on her port and starboard sides have already been fixed, but the operation of plating her has, of necessity, proceeded but slowly, owing to the want of the requisite machinery for preparing the plates. Nearly the whole of this has, however, been now erected in the factory adjoining the building slip, and increased exertions will be used to complete, so far as can possibly be done, the fixing the broadside plates before the frigate is launched. The most complete precautions are adopted to ascertain that each plate is perfectly sound before it is placed on the ship's side, to insure which the most rigid tests are resorted to, when the slightest flaw discovered in the iron results in its immediate rejection. The contract price at which the iron plates are supplied to the Admiralty is £35 per ton, and as each plate weighs four tons, the price of the armour plates used is £140 for each, exclusive of the cost of labour in planing, bending, drilling, and otherwise preparing then and affixing them to the exterior of the ship. On each side of No. 3 dock, tramways have been laid down, and two of the large patent steam travelling cranes from Taylor's Britannia Works, Birkenhead, have already arrived at the dockyard, to be used in hoisting the plates, to facilitate their being fastened to the sides of the frigate as soon as she is docked. The *Royal Oak* is to be made ready for sea with all despatch, and already orders have been received at Chatham that her crew will number 600 officers and men—the same as a line-of-battle-ship.

Trial Trip of the "Racehorse."—The *Racehorse*, 6, screw, 200 horse-power, by Napier and Son, Glasgow, Commander Boxer, tested her machinery at the measured mile, Stokes Bay, near Portsmouth, on the completion of her alterations and repairs by the factory department of the port, prior to her departure for foreign service. The weather was favourable for the trial. The ship drew 12¾ft. of water aft, and 10ft. 10in. forward. The load on the safety-valve was 20lb., with a pressure of steam in boilers of 19¾, and a vacuum of 23in. The maximum revolutions of the engines were 92, and the minimum 90½, the indicated horse-power being 753·18, and the speeds of the ship in knots 10·406. The propeller used was a Griffiths' two-bladed, with a diameter of 11ft., and a pitch of 16½ft. With the port helm over to 31 deg. the ship made a complete circle in 4 min. 36 sec. With the starboard helm over to 25 deg. the circle was made in 4 min 49 sec. The temperature ranged, on deck, from 67 to 63 deg.; in the engine-room, from 97 to 101 deg.; in the fore stoke-hole, from 89 to 110 deg.; and in the after stoke-hole, from 87 to 104 deg. The machinery and boilers gave perfect satisfaction, and, with some slight alterations to her back fire-bars, the ship will be ready to proceed to sea.

"La Gloire."—The *Gazette de Midi* publishes a letter from Toulon of the 29th of July, giving an account of a visit paid by a naval commission on the previous day on board the iron-cased frigate *Gloire* to prepare a report on the effect of the apparatus applied to her machinery to increase the power of her steam. It is said to have been a success. The *Gloire*, having but half her fires lighted, obtained an increase of mechanical force equal to 30 per cent. This invention will be of immense importance with respect to iron-cased ships, as they cannot carry so much fuel as ordinary ships. The experiment tried on board the *Gloire* proves that henceforth ships of her class may proceed to sea with less fuel and obtain a greater speed than under the old system. It is proposed to apply this apparatus to all the steam vessels in the French Imperial navy.

The "Albert Edward."—The South-Eastern Railway have recently added another steamer to their fleet, the *Albert Edward*. Her trial trip took place on the 26th of July, when she attained an average speed of 16.7 knots per hour, and she is now employed on the service between Folkestone and Boulogne, in connection with the special daily tidal trains. She performed the passage between those two ports for the first time on the 12th ult., when, with a strong south-west wind blowing, and 330 passengers, the distance of twenty-six miles was accomplished in ninety-three minutes. The *Albert Edward* and her sister ship, the *Victory*, also the property of the South-Eastern Railway Company, are asserted to be the fastest vessels afloat.

The "Shearwater," screw steam sloop, went outside Plymouth breakwater on the 8th ult., for a trial of her machinery. This sloop carries 11 guns, is about 669 tons burden, and 160ft long by 30ft. broad. She is fully masted and rigged, and draws 12ft. 6in. forward, and 14ft. 2in. aft. Her machinery is well arranged. The doors of the furnaces are some 12ft. on the right of the engineer when on the starting platform, from which he can readily control all the operations connected with his duty. The engines, which are horizontal direct acting, by Messrs. Hawthorn, of Newcastle, are of 150 horse-power nominal. The screw shaft is 64ft. 10in. long by 8in. diameter, and the screw (Griffiths') is 10ft. diameter, with a pitch of 13ft. The immersion of the upper edge of screw, 1ft. 9in.; length on the keel, 2ft. 6in. At the trial the wind was from the south-west, blowing with a force of from 3 to 6 in squalls, attended by a heavy swell. The revolutions were 95 per minute; power indicated, 632 horses; pressure, 20lb.; temperature of stokehole, 79 deg.; engine room, 76; and deck, 62. The average speed attained was rather over 9½ knots, half boiler power; revolutions, 68; indicated horse-power, 251; speed, 7 knots.

Captain Coles and the Admiralty.—It is stated that Captain Coles, R.N., is retained by the Admiralty to superintend the fitting of the shield ships, upon a pay of three guineas a day, as a civil engineer, irrespective of his position as an officer in her Majesty's navy, with two draughtsmen under his orders, paid by the Admiralty. Captain Coles also receives the sum of £5000 in payment of all expenses hitherto incurred by him in bringing his knowledge of the shield principle to its present state, and will receive a further sum of £100 for each shield fitted on board her Majesty's ships.

The "Resistance."—Orders have been received at Chatham for every exertion to be used in completing the fitting of the iron frigate *Resistance*, 18, 600 horse-power, Captain Chamberlain, attached to the steam reserve, in order that she may be ready as soon as possible to proceed to sea.

STEAM SHIPPING.

A Handsomely Moulded Yacht Steamer, said to be intended as a present to the Emperor of Japan, was successfully launched on the 2nd ult. from the Pembroke Dockyard arsenal. Her dimensions are as follows:—Length between perpendiculars, 220ft.; length of keel for tonnage, 200ft. 1in.; breadth extreme, 28ft. 2in.; breadth for tonnage, 28ft.; breadth moulded, 27ft. 2in.; depth in hold, 14ft. 6in.; burthen in tons, 834.

The "Volunteer" iron screw steamer, was recently launched from the yard of Messsrs. Marshall Brothers, on the Tyne. The following are her dimensions:—Length over all, 200ft.; breadth, 29½ft.; depth, 17½ft. The engines of the *Volunteer* will be 90 nominal horse-power, and her gross register 700 tons, class A1., 9 years. She has been built for a Sunderland firm, and is intended for the Baltic trade.

The "Apollo."—A large paddle steamer for the Bristol Steam Navigation Company was launched from the building-yard of Messrs. Caird and Co., Greenock, on the 16th ult. Her dimensions are 230ft. 6in. long, 26ft. beam, 14ft. 6in. depth of hold. She will be fitted with a pair of oscillating engines of 260 horse-power collectively.

The "Pilot" was launched from the building-yard of W. A. Woodhouse, South Shields, on Monday, the 18th ult. Her dimensions are:—Length, 73ft.; breadth, 16½ft.; depth, 9ft. The engines, of 3-horse power, will be fitted in by Mr. Scott, North Shields.

The "City of Melbourne," a finely-modelled screw steamer, has been recently launched from the yard of Messrs. J. and G. Thomson. This vessel is 950 tons burthen and 250 horse-power, and has been built for the Australian Steam Navigation Company.

The "Tyne," Royal Mail steamship, was taken to Stokes' Bay on the 2nd ult., for an official trial, previous to resuming her place on the Southampton and Brazil Line. She ran the measured mile four times, attaining a speed of $13\frac{3}{10}$ knots per hour; pressure of steam, 20lbs.; revolutions of engines, 21; vacuum, 28; steam from superheaters, 310 degrees; 380 tons of coal being on board. The performance of the vessel, and the easy working of her machinery, gave the greatest satisfaction to all present.

Screw Steamer for the Italian Postal Service.—Messrs. C. Mitchell and Co. have lately completed the construction of an iron screw steamer for the above service. The steamer has been named the *Liguria*, and is destined to carry passengers and the Italian mails between Genoa and the Island of Sardinia. The unusually high speed of 13 knots per hour was guaranteed by the builders, and the following account of the trial of the vessel, under steam, shows the actual performance to be considerably in excess of the requirements of the contract. Before giving the result of the trial, it will be useful to those interested in steam navigation to know the general characteristics of the steamer. The *Liguria* is of the following dimensions:—

Length over all	195 feet.
Length on water-line	178 „
Breadth of beam	25 „
Depth of hold	14 „

Tonnage, 550 B.M.

The vessel has an elliptical stern and clipper bow, has fine lines both fore and aft, and is altogether a very handsome looking craft. The internal accommodation for passengers is of the most elegant and costly description. The saloon for first-class passengers is under the poop deck, and is constructed of various ornamental woods, beautifully inlaid and relieved by gold mouldings and carving. The engines are from the workshops of Messrs. R. Stephenson and Co., and are made on these makers' patent horizontal principle. The cylinders are 42½in. diameter, and 2ft. 6in. stroke. The boilers are tubular, with brass tubes, superheating apparatus, expansion valves, and other appliances for the economy of fuel have been made use of; and the entire external surface of the boilers has been covered with felt and sheet lead, for the purpose of preventing the escape of heat. The *Liguria* was taken to sea on the 23rd July, to test her machinery, and the speed of the vessel under steam. She steamed from Tynemouth to Hartlepool, a distance of 21 nautical miles, in 95 minutes, andr eturned to Tynemouth, over the same distance, in 93 minutes, thus giving an average speed of 13½ knots per hour. The average time of running a measured distance of 2¼ knots, with and against tide, was 9¾ minutes, being equal to about 13¾ knots per hour. The engines, during the above trials, were working at 80 revolutions per minute. Other experiments were made at various speeds of engines; and during eight hours constant steaming, there was not the least indication of hot bearings, thus proving the accurate adjustment of all parts of the machinery. The trials were conducted by Messrs. C. Mitchell and Co., and Messrs. R. Stephenson and Co., Captain Tortello being present on behalf of the owners, accompanied by Mr. Pike, the Company's engineer.

The "Psyche," paddle despatch gun-vessel, fitted with engines of 250 horse-power, by Messrs. John Penn and Son, the first of her class afloat, made her official trial of speed on the 11th ult., at the measured mile in Stokes Bay. The cylinders have a diameter of 62in., with 4ft. 6in. length of piston stroke, the area of the cylinders being 3019 square inches. The diameter of the wheels is 18ft.; the quantity of coals on board, 230 tons; draught of water, 10ft. 7in. aft. and 9ft. 7in. forward. The engines are fitted with disengaging apparatus, and the boilers with superheaters. The ship is of 835 tons, built from Admiralty drawings. On nearing the *Warner* light-vessel the *Psyche's* head was brought round and laid for the trial ground in Stokes Bay, where eight runs were made at "the mile," as follows:—In the first run the time was 3 min. 46 sec.; the speed in knots 15·929; the pressure of steam, 27lb.; and the number of revolutions of engines, 32½. In the second run the time was 4 min. 47 sec.; the speed in knots, 12·543; the pressure, 27lb.; and the number of revolutions, 32¾. In the third run the time was 3 min. 39 sec.; the speed in knots, 16·438; the pressure, 29lb.; and the number of revolutions, 33. In the fourth run the time was 4 min. 40 sec.; the speed in knots, 12·857; the pressure, 28lb.; and the number of revolutions, 34. In the fifth run the time was 3 min. 44 sec.; the speed in knots, 16·071; the pressure, 27lb.; and the number of revolutions, 33½. In the sixth run the time was 4 min. 29 sec.; the speed in knots, 13·383; the pressure, 27lb.; and the number of revolutions, 33½. The mean speed of the whole was 14·521 knots. The vacuum of the engines ranged from 24 to 25 inches. At the conclusion of the full-speed trials the ship was steamed out to the southward to ease the steam down and cut off the two after-boilers to test the ship's speed at half power, which was carried out in two runs with the following results:—First run—time, 4 min. 18 sec.; speed in knots, 13·953; revolutions of engines, 28½. Second run—time, 4 min. 44 sec.; speed in knots, 12·676; revolutions of engines, 30. The mean speed of the two runs was 13·314 knots. In making the circle complete, with the helm to starboard, the ship came round to port in 5 min. 24 sec., the rudder being over at an angle of 15½ degrees. Round to port the circle was made in 5 min. 28 sec., the rudder being over to 29 degrees; the revolutions of the engines being, in the first instance, 29½, and, in the second, 28. From the time of giving the word the engines were stopped dead from full speed in 30 seconds, started ahead in 16 seconds, and started astern in 35 seconds. The diagrams of the indicator and expansion cards were of unusually favourable character. At full speed the ship carried a tremendous wave under her bows, while at half speed she carried one not a quarter the size. The *Psyche* may be looked upon as a 11¾ to 12 knot vessel at sea, taking the average of weather. The engines and boilers gave the greatest possible satisfaction by their working. The *Psyche* is a sister vessel to the *Enchantress*, launched at Milford; the *Helicon*, building at Portsmouth, and the *Salamis* at Chatham.

TELEGRAPHIC ENGINEERING.

Mediterranean Extension Telegraph Company.—At the half-yearly meeting of the shareholders of this company, a dividend at the rate of eight per cent. per annum on the preference shares was declared, and a dividend of 4*s*. per share, or at the rate of four per cent. per annum, free of income tax, on the ordinary share capital, was also declared.

RAILWAY ACCIDENTS.

Railway Collision.—A collision, unattended with loss of life or any very serious injury, occurred on the Great Northern Railway on the 18th ult. A passenger train, consisting of about 16 first and second class carriages, left the Leeds station at a quarter-past ten in the morning for London, but owing to the heavy character of the gradient of the line a short distance from Leeds, and the weakness of the steam power of the locomotive by which it was led, the train came to a stand, or nearly so, at the Holbeck junction, which is approached by a bold curve. A passenger train for Bradford was following on the same line, and it was deemed advisable that this train should give the former one a push on its way. Unfortunately, the driver of the Bradford train drove it with too great force against the standing train, and the break-van of the latter was a good deal injured by the collision, as were also a great number of passengers.

Accident to an Excursion Train.—On the 20th ult. an accident occurred to a return excursion train on the Leicester and Hitchin branch of the Midland railway. The train left King's-cross in the morning for Bedford, in connection with the Bedford Regatta. The return train left Bedford station at 6.20 p.m., and proceeded at about thirty miles an hour to Hitchin; when within a mile or two of the latter place it slackened speed, and at about a quarter of a mile from the station, just before its arrival at the junction with the Great Northern line, the excursion train ran into a cattle train standing near the platform. The collision was so violent that the first three trucks, containing sheep, were thrown off the line, forced against the platform, and broken. The passengers, about 200, were most of them injured by contusions upon the head, face, and knees, some complaining of internal injuries. Those most severely injured were conveyed to the houses in the neighbourhood and attended .

The Cost of a Railway Accident.—At a recent meeting of the shareholders of the London, Brighton, and South Coast Railway, in reply to a question respecting the amount of loss which had arisen to the company in consequence of the accident in the Clayton tunnel, the Chairman said that, as regarded this unfortunate affair, £11,000 had been paid when the previous half-year's report was published; and in the present report £6000 was charged in respect of the accident; and a similar sum would be placed to the debit of the present half-year. The total cost, therefore, might be said to be £24,000. This, without taking into account the loss of life and other damage, ought to teach the necessity for not sparing the necessary expense in the employment of competent persons in connection with railways, and using the care which is required to prevent such sad events.

Accident on the London and North Western Railway.—On the 1st ult. an accident occurred, fortunately unattended with fatal results, occurred on the London and North-Western Railway, between Manchester and Liverpool. The express train, which leaves Victoria Station, Manchester, at 2.45 p.m. proceeded on Thursday, as usual, with passengers for Liverpool, Chester, &c., taking up at Ordsal-lane a carriage of the Great Northern Railway Company, which was placed next to the engine. Following that were a guard's, van, seven carriages, and a van also at the rear of the train. On its arrivai at Newton junction the carriages for Warrington and Chester were detached, and the train proceeded on its way. Arriving near the Earlson waggon works, the driver observed an engine shunting across to the main line with some empty waggons, and the shunting engine became almost stationary. The intervening distance at this time was not more than fifty yards, and the express dashing on at the rate of thirty miles an hour. The driver did all in his powet to stop the train without effect, and it came into fearful contact with the shunting engine. The express engine leaped up, and swaying over fell among some waggons with which the sidings were filled. The driver of the express train stuck to the engine, and escaped, only a few of his ribs being bruised and he being hurt a little about the head; the stoker was also unhurt, he having jumped off, received nothing more than a severe shaking from rolling over. The most alarming consequences to the passengers were anticipated, for there were the Great Northern carriage, the guards's van, and another carriage broken to pieces; the first one being quite a wreck, but as stated above no one was fatally injured.

RAILWAYS.

Moldavian Railway Company.—The prospectus has been issued of a joint-stock association, called the Moldavian Railway Company. The capital is to be £2,240,000 in debenture bonds. Interest at six per cent. per annum on is to be allowed on the paid-up capital during construction, and a minimun dividend of six per cent. per annum on the whole capital is guaranteed by the Government of the United Principalities of Moldavia and Wallachia, payable as each section is opened. The subscriptions are receivable in seven payments for each £20, extending over four years. The concession of the company dates from April, 1862, and expires December, 1963. The main line is to be about 220 miles in length, and will commence at the port of Galatz, and, following the valley of the Sereth, passes through several towns till it reaches the north-west frontier, whence there are two branches, one to Jassey and the other to Akna. The line, in conjunction with the proposed extension of the Austrian Charles Louis Railway, will establish an unbroken and direct communication between the Baltic, the German Ocean, and the Black Sea. By this route it is said that London will be brought within sixty hours of Galatz, and seventy hours of Odessa and Southern Russia. Constantinople will be reached in four days, and the *entrepots* for the Caspian, Persia, and Central Asia in five days, and Alexandria in seven, and thus establish a new and independent route to India, Australia, &c.

Buenos Ayres Great Southern Railway Company.—The prospectus has been published of the Buenos Ayres Great Southern Railway Company. The line is to extend from the city of Buenos Ayres to Chascomus, a distance of about 75 miles. The capital is £750,000 in shares of £20; and interest is guaranteed by the Government for the term of forty years, at 7 per cent. Its cost is not to exceed £10,000 per mile, and it is to be completed in sections. The Government reserves to itself the right to be repaid out of subsequent surplus profits any advance it shall make under the guarantee. It is stipulated that the line shall be commenced within eighteen months from June last, and completed in four years. The Government possesses the right of purchasing the line on payment of 20 per cent. profit on its original cost, admits all articles for its construction and use into the country free of duty for forty years, and exempts its property from taxation for the same period.

Railways in Ceylon.—On Monday evening, August 3rd, in the House of Commons, Sir F. Smith asked the Under Secretary of State for the Colonies whether he had received any and what tenders for a railway from Colombo to Kandy; and if the Secretary of State for the Colonies had received any communication relative to a proposed tram-railway from Colombo to Trincomalee, with a branch to Kandy, so as to develope the vast agricultural capabilities of the colony. Mr. Fortescue replied that several tenders had been received, but at present it would be unadvisable to state publicly their nature or amount. A proposal for a tramway had reached the Secretary of State, who had intimated that he had no objection to forward a statement on the subject to the Government of Ceylon.

MILITARY ENGINEERING.

Armour Plate Testing.—In the testing of four armour plates on the sides of the *Sultan*, target ship, at Portsmouth, on the 28th July, with the 68-pounder gun of the *Stork* gunboat, only one underwent the test with credit. Three of the plates proved to be not only defective in the grain of the metal, but more particularly so in the welding of the layers. The one plate alluded to proved to be of a very fair character, both in grain and welding. It was supplied by Mr. Cheney. In some experimental firing, carried out on the 30th of July, a couple of homogenous metal 10-inch shells, filled with molten iron, were fired at an undamaged part of one of Brown's (of Sheffield) best plates, on the side of the *Sultan*, and the result proved that armour plates may be as readily broken by this description of missile as by a solid 68-pound shot. The gun used was one of 84 cwt., 10in. bore, with a charge of only 9lbs. of powder; the distance being 100 yards. The indentation made on the plates was 1·6in. and 1·8in. respectively.

Fortifications.—A return issued on the 4th ult. gives the amount expended to the 30th of June, 1862, out of the Consolidated Fund, for the expense of fortifications. The sum expended for fortifications of land was £388,736; but the return states that purchases of land have been made, involving further liabilities to the estimated amount of about £640,000. The expenditure on works was £702,203, but the bills for work done in June last under this head have not yet been received.

An Explosive Compound, by John Horsley, F.C.S.—If nine parts of well-dried and finely-powdered chlorate of potash be mixed with three parts of finely-powdered galls, a highly explosive compound is formed, which needs no granulation. As it will not admit of trituration in a mortar, the mixture should be made on paper by means of a bone spatula, or by passing it through a fine brass sieve. The strength of common gunpowder may be increased by working up with the powdered meal about twelve per cent. of powdered galls, and regranulating it. I have been acquainted with this for several years, but never published it before.

The Bristol Channel Defences.—The projected fortifications for the defence of the Bristol Channel and the estuary of the Severn are at once to be erected. On the English side of the Channel a heavy battery will be erected on the extreme western point of Break Down, a promontory which runs out a considerable distance into the Channel, having a high elevation throughout. The second defence will be batteries on each side of the Steep Holmes, the third similar batteries on both sides of the Flat Holmes, the third similar batteries on both sides of the Flat Holmes, and the fourth defence a fort mounting heavy ordnance at Lavernock Point, a promontory just below Penarth Roads. Between these defences a very formidable cross-fire could be maintained. In no case would the ordnance be required to command a greater range than 2000 yards.

BOILER EXPLOSIONS.

Manchester Steam Boiler Association.—At the last ordinary monthly meeting of the Executive Committee of this association, Mr. L. E. Fletcher, the chief engineer, presented his monthly report, of which the following is an abstract:—"During the last month there have been examined 323 engines and 563 boilers. Of the latter, 2 have been examined specially, 1 internally, 95 thoroughly, and 465 externally, in which the following defects have been found:—Fracture, 16 (2 dangerous); corrosion, 46 (8 dangerous); safety valves out of order, 11 (1 dangerous); water gauges ditto, 19 (4 dangerous); pressure-gauges ditto, 14; feed apparatus ditto, 11; blow-off cocks ditto, 28 (1 dangerous); fusible plugs ditto, 6; furnaces out of shape, 10 (3 dangerous); blistered plates, 7; total 168 (19 dangerous). Boilers without glass water gauges, 12; without pressure gauges, 2; without blow-off cocks, 50; without back pressure valves, 98. Three explosions occurring during the past month, to boilers not under the inspection of this associatian, have come to my knowledge. One of these took place in Manchester, the other in the neighbourhood of Newcastle, and the third in London, while all three were attended with fatal consequences. The plates of the first are reported as having been found on subsequent investigation so reduced by corrosion, as not to have exceeded the thickness of a sheet of paper, while it is worthy of remark, with regard to the second, that its explosion had seriously damaged another boiler alongside of it, which, however, fortunately happened at the time to be out of work, or, from the injuries it received, it must have exploded in turn. This is frequently found to be the case, and the fact is of interest, as affording an indication of the variety of forces developed by explosion, which, as has been previously pointed out, evidently cannot be summed up merely in that of disruption and the reaction consequent on unbalanced pressure. In addition to the above, however, it becomes my duty to report the occurrence of an explosion to one of the boilers belonging to a member of this association, and which, it is to be regretted, was attended with loss of life to the fireman. This is the third fatal explosion which has happened to any of the boilers under the inspection of this association since its establishment, nearly eight years ago, to which should be added three cases of collapse of furnace flues, not attended with any serious consequences, and which arose in two instances, if not in all three, from shortness of water. During this period 656 dangerous defects have been pointed out in the boilers under inspection, from which serious injury might have arisen in each case; while upon limited inquiry only, it has been found that no less than 202 fatal explosions have occurred in that time to boilers not under the inspection of this association, which have been attended with the loss of 438 lives, in addition to serious injury to 476 persons, and considerable damage to property. The explosion last referred to occurred to one of a pair of ordinary cylindrical double-flued boilers, working side by side and connected together. Both boilers were set upon mid-feathers, and were of precisely similar construction and dimensions, the length of each being 34ft., the diameter of the shells 7ft., of the flues 2ft. 7½in., and the thickness of plates ⅜in. throughout, with the exception of the flat-ends, which were 9-16ths of an inch. The fittings consisted in each case of a glass water guage; a back pressure and feed stop valve combined; a blow-out valve, of mushroom construction, opening against the pressure in the boiler; and a lever safety valve, loaded with a single weight to a pressure of 35lb. per square inch; in addition to a steam pressure gauge common to both boilers as long as both junction valves were open, but not otherwise. The explosion was occasioned by a rent in the shell, which took place directly through the line of rivets at one of the longitudinal seams in the second ring of plates from the front of the boiler, the seam being on the right hand side, 3ft. from the centre or 'keel' line at the bottom. The construction of this seam was such that the edge of the outer plate was uppermost. The cause of the rent was thinning of the plates at this seam by external corrosion, through which it had become reduced to about 1-16th of an inch in thickness. The corrosion extended throughout the length of the seam, which was about 2ft. 6in., and affected the plates on both sides of the lap to a width of from 4in to 6in. The rent did not extend longitudinally beyond the limit of this ring of plates, but ran along the transverse seams of rivets on each side of it, almost severing a complete belt from the boiler. The reaction from this opening raised the boiler momentarily almost on end, as was attested by the character of the fracture of the connections, the indentations in the bottom plates, and the fact that a pipe, previously overhead, had become buried beneath it, while the twin boiler alongside was blown bodily in a lateral direction. Had the longitudinal seams of rivets, instead of breaking joint, been in line, which is too frequently the case, the rent would certainly have run from one end of the boiler to the other, and the destruction of property, and very probable that of life also, have been more serious. This defect was one that could scarcely have escaped detection on a careful examination of the condition of the plates in the external flues. Still it should be borne in mind that the plates of boilers set on mid-feathers, are neither as accessible or visible as they are in those set on two side walls with a split flue. The side flues in the latter case admit of coming face to face with the plates and seams in a manner which cannot be done in the former, in which many of them can only be seen obliquely at a very great disadvantage, while those at the upper part of the flue, in what may be termed the tip of the wing, are frequently out of reach altogether.

A Boiler Explosion which proved fatal to two men and severely injured a third, took place, on the 17th ult., at the Scot Lane Colliery, near Wigan, the property of Messrs. W. Woods and Sons. The boiler which exploded is one of a series of six used in working the colliery, and on the evening above named they were all at work, an engineer and fireman being in charge. These men were present in the engine-house, together with a farmer's labourer, when the accident took place. On examination it was found that the plates round one of the boilers in the centre of the six had been forced completely off, and the boiler thus divided into two portions, the smaller of which was thrown into the fire hole, and the larger, about 24ft. long and four tons weight, blown with great violence against a chimney behind the engine house. This it knocked down, and then proceeded across the adjacent field for about 80 yards. The roof of the engine house was almost entirely destroyed, the windows broken, and the bricks scattered in all directions across the works.

DOCKS, HARBOURS, CANALS, &c.

Thames Embankment Commission (Surrey Side.)—The commissioners appointed to examine plans for embanking the Surrey side of the River Thames, within the metropolis, and to report which of the said plans of embankment would conduce with the greatest efficiency and economy to the improvement, embellishment, and convenience of that part of the metropolis, improve the navigation of the river, and provide a public thoroughfare without stopping such trade as must be carried on upon the bank of the river, and also upon the cost and means of carrying the same into execution, have reported as follows:—"The nature of the inquiry entrusted to us was made known by advertisements in the newspapers, and 20 designs were submitted for consideration. A short description of each is appended. The authors have attended, given full explanations, and stated their respective views, as will be seen in the evidence hereto annexed. We must here express our opinion of the excellence of many of the plans submitted to us; and although we cannot recommend any one plan for adoption in its entirety, as meeting all the requirements of the case, yet the principal features of some of them are embodied in the plan we have the honour to suggest. Some of the plans comprise the whole length of the Surrey shore from Deptford to Battersea Park; and we have accordingly directed our inquiries to that extent. We propose to divide this district into three sections; the first extending from Deptford to Westminster-bridge; the second from Westminster-bridge to Vauxhall-bridge; and the third from Vauxhall-bridge to Battersea-park. With respect to the first section, as the existing thoroughfares with the new street now being made between Southwark and Blackfriar's-road will, in our opinion, afford sufficiently convenient and direct means of communication for the traffic—and as the flooding of the low-lying districts could be obviated by a more efficient system of drainage—there does not appear to us any public necessity for an enbankment and roadway between Deptford and Westminster-bridge. The formation of such a roadway would involve a vast expenditure of money, and cause a great disturbance of the trade and commerce of that part of the metropolis. If, however, the owners and occupiers of such wharf property should be desirous at any time of constructing an embankment, which, whilst increasing their own accommodation, would ensure uniformity of design and improve the navigation of the river, we are of opinion that every facility should be afforded them for so doing, although we are unable to recommend that the cost should be defrayed by the public. With respect to the second section, namely, from Westminster-bridge to Vauxhall, we are of opinion that a new and improved communication is necessary, and this, we think, may be effected by constructing any embankment and roadway between these points. The property adjacent to the river between Lambeth Church and Vauxhall-bridge is of a inferior character. The wharf walls are insufficient to keep out the water at high tides; hence many of the streets are at times flooded, causing distress and sickness to the inhabitants, who are for the most part of the poorer classes. Between Vauxhall-bridge and Battersea-park, which comprises the third section of our inquiry, an embanked roadway would afford access to the Battersea station of the South Coast Railway, and to the goods station of the South Western, and Chatham and Dover Railways, would improve and embellish that part of the metropolis, and afford a convenient and agreeable approach to Battersea-park from the densely populated districts of Lambeth and Southwark. We therefore, humbly submit to your Majesty that an embanked roadway of about two miles in length should be formed between Westminster-bridge and Battersea-park, commencing at the east abutment of Westminster-bridge, on a viaduct of an ornamental character opposite to the Houses of Parliament, as far as Bishop's-walk; thence on a solid embankment to the north side of the London Gas Works, continued under Vauxhall-bridge as far as Nine Elms on a viaduct, and thence upon a solid embankment, passing under the land arch of the railway bridge, and terminating at the approach road of the new suspension bridge at Battersea. The plan and section, which are appended to the report, show the direction and levels of the intended road, and the arrangements proposed for accommodating some of the occupiers of the most important of the water-side premises; and in suggesting viaducts we have endeavoured not to interfere, more than is absolutely necessary, with the trades which must be carried on upon the banks of the river. The dredging of the foreshore in front of the embankment to a level of five feet below low water will (particularly at Lambeth and Nine Elms) improve the navigation, compensate to a great extent for the loss of tidal water displaced by the solid portions of the embankment, and as the foreshore will be formed, under the viaduct, of solid material, and on a suitable incline, it will tend to prevent accumulations of mud where the shores are flat or uneven. Communications with the embankment would be made at Stangate, by prolonging Palace New-road, and widening Bishop's-walk on the western side, Church-street, Broad-street, Vauxhall-row, High-street, Battersea-road, near Nine Elms Goods Station, New Park-road, leading to Wandsworth, and the station of the London, Chatham, and Dover Railway Company. The estimated cost of this work, including land and compensation, is £1,100,000; but it is important to observe that if the present favourable opportunity for carrying out this great work be not at once embraced the cost will necessarily be much greater, by reason of the increasing demand for land and buildings for trade purposes in and near to the metropolis. This scheme would be a metropolitan improvement; and with reference to the means by which the cost is to be defrayed we consider that the coal and wine dues should be appropriated for such a further period as may be necessary for the purpose."

Suez.—The Sweet-water Canal, which the Suez Canal Company is making, is expected to reach Suez next winter, and will, we anticipate, prove of great benefit for the healthy state of the town.

Suez Docks.—The engineer, Mr. Stecklin, and the contractor, Mr. Dussot, of the dock about to be commenced at Suez, arrived at that town the beginning of last month; and the works are to be commenced forthwith. This dock, when completed, is, we understand, to be handed over to the Egyptian Government for the sum of six millions of francs (£250,000).

Destruction of the Works at Plymouth Breakwater.—The whole of the works that have recently been erected in Plymouth Sound for the purpose of constructing the foundation upon which it is to be built, the new fort just inside the Breakwater, were, on the 25th ult., entirely carried away. So complete has been the destruction, that nearly the whole of the labour expended there during the past six months has been entirely lost, and much of the material destroyed. For several months a large body of men, sometimes reaching to 190, have been employed in preparing the Shovel rock, and raising a huge scaffold thereon. This scaffold, which was begun in February last, was to consist of a circle of piles 70ft. in length round the site of the foundation, and driven into the rock with iron shoes 4½in. square, and 5ft. in length. These piles, supported by guys carried out around, and secured to lewises (a suitable form of iron ring bolts), were inserted into the rock. Rows of large pieces of timber, technically termed longitudinals, were to extend from pile to pile, and along the top tramways were to be laid for the trollies or travelling cranes, by which the massive blocks of stone and concrete prepared at the works at Laira, were to be lowered down into their respective positions in the foundation. Up to the 25th ult., the piles were driven, the guys extended, and the men were employed in laying the longitudinals, which they had effected up to the level of the water. At low tides about 40ft. of piles were exposed to the winds, and the structure had not yet received the consolidation it would have acquired by the further rows of longitudinals that were to be laid, and the tramways at the top. It had stood several strong breezes from the southward and westward without apparently being in any way injured, but this was the first occasion on which a strong easterly wind had prevailed since its erection to its then height. About eleven o'clock in the forenoon, when near low water, and the work was being proceeded with as usual, some of the guys and piles to the eastward gave way, and rapid destruction followed, the whole of the piles being within a few minutes broken off, and floating on the surface of the water. They nearly all appeared to have parted at their shoes. At the time of the accident there were only seven men on the piles; they most fortunately escaped with only the immersion, with the exception of two, who were somewhat roughly bruised.

BRIDGES.

BULAH VIADUCT.—In the construction of the Bulah Viaduct, four miles from the town of Brough, in Westmoreland, an ingenious and novel mode of erection was adopted by the contractors, Messrs. Gilkes, Wilson, &c. They used no scaffold, but having commenced the erection of the first pier from the abutment, they swung each piece of the iron work of the pier by counterbalancing it with a shifting weight-box as it swung, and thus were enabled to lower it steadily to its place. When the first pier was erected they placed two bulks across from the abutment to the pier, and ran the girder over, dropping it into its place with the assistance of the crane. On the completion of the first span the crane was moved forward, and the other piers were erected and connected by girders in the same manner. By this mode of erection the viaduct was completed in the almost unprecedentedly short time of four months.

ACCIDENT TO LAMBETH SUSPENSION BRIDGE.—On the 15th ult. a singular accident befel the new suspension bridge that has been nearly completed over the Thames, between Lambeth and Westminster at the old Horseferry. It appears that the roller over which the main suspending rods were stretched suddenly subsided, slackening the chain and causing such a jerk to the pier on the Middlesex side that it bulged out considerably from the perpendicular. The jerk was felt in other quarters; on both banks of the river the concussion felt like the shock of an earthquake; even Lambeth Palace felt the vibration. A forge erected near the cylinder was overturned by the shock, and one of the smiths working there was hurt, but this was the only injury to life or limb.

MINES, METALLURGY, &c.

APPARATUS FOR BORING ROCKS.—An invention has just been patented for Mr. E. Lisbet, of Paris, which relates to an improved apparatus for boring rocks or other mineral substances, as also to the construction, arrangement, and mode of working the perforating or boring tools or apparatus employed for boring holes in rocks for mining or quarrying operations. The improved boring tools or apparatus may be classed under two heads. In one arrangement, apparatus for operating the tools is provided with toothed or other gearing, and in the second arrangement the toothed gearing is dispensed with. The first and more complete arrangement consists of a rectangular frame, in the internal faces of which there are two side groves in which work the sides or arms of a moveable forked frame. The arms of the movable frame are provided with ratchet teeth, and the two side pieces of the rectangular frame have notches made therein, so as to present the appearance of a double rack united at top and bottom by cross-pieces. The lower of these cross-pieces carries a double projecting prong, which is movable on its axis, and is intended to rest against the sides of the excavation. The upper cross-piece is tapped, and has a female screw made therein, in which works a male screw, which is actuated by a pinion, whose bearing is secured to the cross-piece of the rectangular frame. This pinion is actuated, by means of a winch, and gears into a bevil wheel on the male screw, so that the latter may be made to rotate in the female screw. A double projecting prong is attached by a swivel joint to the upper end of the forked frame, and by causing the male screw above mentioned to rotate in its socket, the double prongs at each end of the apparatus are made to recede from each other, and may, therefore, be forced into the sides of the excavation, so as to hold up the framing that supports the perforating tool; this tool is secured in a suitable holder attached to a box or carriage, which is capable of being moved to and fro in the rectangular frame, so that it may be adjusted to any required position on the frame. Rotary motion is imparted to the boring tool by means of a winch handle, and the tool is made to advance into the hole as the boring operation proceeds by means of screw gearing. A simpler form of apparatus may be made by making two frames movable one within the other by hand instead of by gearing. One end of each frame is provided with a centre point for the apparatus to rest on. The upper point may be elevated by a screw working in a box by means of a hand lever instead of by toothed gearing as in the former instance, and the moveable frame with the box that carries the boring tool is supported in any required position by means of clicks made to take into the ratchet teeth of a rack on the sides or face of the movable frame. The box which carries the boring tool is supported at any point on the rectangular frame by pins that rest in notches cut on the face of the frame. The boring tool is actuated as in the former instance.

CORNISH TIN MINING.—The Parkgwyn Tin Mining Company, Limited, has been formed to work some very valuable deposits of tin ore near St. Austell. The company propose to put up machinery immediately, including a good sized pumping engine. The undertaking appears to be one of considerable promise.

DESULPHURATION OF IRON IN PUDDLING.—Prof. Richter, of Leoben, Styria, recommends the oxide of lead (litharge) for this purpose; and in an experiment in which 4 lbs. of litharge were added to 865 lbs. of iron, 4 lbs of sulphuret, and $\frac{3}{4}$ lb. of phosphuret of iron, the results were wholly satisfactory, the iron being entirely soft and malleable. The operation was, moreover, finished in much less than the ordinary time.

VENTILATION REGISTER AND DETECTOR.—At the Birmingham meeting of the Northern Institute of Mining Engineers, Mr. G. T. Woodhouse, of Derby, called attention to an invention by Mr. Wm. Buxton, viewer at Springwell Colliery, Staveley, for ascertaining the quantity of air in a mine, and regulating the firing at the furnace, and he recommended it to the notice of all parties interested in the management of collieries. In a large batch of papers issued by the Institute within the last few days we find a description of the instrument, and inasmuch as the invention is not patented we publish a summary of the details for the benefit of those of our readers whom it may concern. The performance of the apparatus is described as consisting in—1. The indication by separate fingers upon one index face of the quantity of air actually passing along each return at the time of observation.—2. The registration by separate pencils upon one register paper of the quantity of air at any desired intervals throughout the day, or any longer period.—3. Warning the furnacemen at any desired intervals to attend to the furnace.—4. The accumulation of proofs that the furnaceman has done his duty, or that any other official has been at the instrument at any required time.—5. The indication of the progress of time. The action of the instrument is as follows:—Supposing its registering and indicating parts to be enclosed in a locked box at the furnace, near to which any number of main returns meet, then at a convenient place of ascertained area in each return is fixed upon a hinge a sheet, or vane, of copper. On the opposite side of the hinge a rod moves simultaneously with the sheet, and to this rod is attached a hair wire, which after passing into the indicator box and over a pully is connected with a weight, pencil, and index finger sliding up and down a cylinder, so that the greater the pressure upon the vane the higher the pencil rises, and if the pressure decrease the weight brings them down. The three pencils move in the same vertical plane upon a vertical cylinder, on which the register paper is rolled. Each pencil's range upon the paper is within ascertained vertical limits, and for each return a portion of the register paper is divided horizontally, in exact correspondence with one scale on the index face, from data obtained by repeated measurements of the volume of air current at the pressure sheet or vane, and simultaneous noting of the registration, such divisions remaining correct so long as the area of the place in the air-course where the pressure sheet is fixed continues the same. Vertical lines on the paper mark the intervals of time. To give periodical motion to the cylinder coiling the register paper, to ring the bell, &c., a small supply of water is required, and the water provided at furnaces for wetting the slack may be first used in working the instrument. The water flows into a tank, whence it runs into a lower tank, in which an uniform head is maintained by means of a waste pipe. From the lower tank an adjusted tap admits the water into a trough with a sloping bottom, at the deep end of which, and forming part of it, is a box with balance weights. The trough when nearly full overbalances, and working upon a horizontal axis tips upon its shallow end. This end is covered, except a slit level with the top, through which the water escapes gradually, until the box preponderates, when the trough returns to its former position. The cylinder on which the register paper is rolled fits upon a square axle projected upwards from the centre of a circular horizontal toothed metal plate, which is alternatety pulled and pushed one tooth forward by two rods, one fixed on each side of the tipping trough. A finger, pointing to the time upon a dial, may be moved round by the peg-plate; a bell may also be rung by a projection from the tipping trough striking the bell lever. The peg-plate is fitted with numbered pegs, one of which comes to a slit in the box each time the bell rings, when the furnacemen is required to attend to the furnace, and at the same time to record proof of his attention by taking out the peg, and dropping it into a peg-holder. Should he neglect the missing peg betrays him, and the registering pencils may be expected to confirm the charge. It is intended that the register papers should be entered daily, and preserved in a book at the colliery office, for the examination of the Government Inspector at all times, and for production before a jury in the event of fatal accidents.

QUARTZ CRUSHING AND AMALGAMATING GOLD.—The following is a description of operating gold quartz at the Pioneer Mills in Esmeralda:—This mill is run by steam power, using a rotary battery and running eight stamps; its capacity with double screens on is to crush four and a-half tons per day; without screens, it can crush from five to six. The rock while being crushed is fed with hot water, which causes the amalgamation to work more readily. The pumice passes off through a spout into what are called "Howland's amalgamating pans;" thence into an arastra, and from thence into a precipitating or amalgamating vat, and is then conducted into what are called "Varney pans," which act as mullers, and grind the pumice down to a perfect pulp, when the final amalgamation is completed; this pulp is now greatly reduced by water, and is carried off by a spout and flows over blankets; these latter catch and retain the sulphurets and the finer particles of metal which the amalgamators fail to gather; the blankets are then washed by hand, and the sediment is reduced by what is termed the "Hatch process," which is extensively used at Virginia and Gold Hill. This mill is now crushing rock from the "Wide West" ledge, the owners having a contract to crush 1000 tons. From a crushing of twenty-seven tons of rock from this load, a sum of 3126 dols. 83 cents., or an average of 115 dols. 80 cents. per ton was realised; this was independent of the blanket washings, which would increase the returns to a fraction more.

TWO NEW COLOURING MATTERS RESULTING FROM THE OXIDATION OF PHENIC ACID, BY M. FRED. FOL.—I have been led to the discovery of this colouring matter by the results of a series of experiments undertaken for the purpose of studying the action of bisulphate of mercury and other bisulphates on aniline and the other compounds of phenyle. Bisulphate of mercury producing, under rather singular circumstances, a red similar to fuchsine, I hoped to arrive at the same result by combining the action of bisulphate of mercury and other bodies on phenic acid. In place of what I sought for I obtained a reddish-brown resinous matter, yielding, with alkalies, very soft red and rose colours, and by itself dyeing yellow. The reaction, with heat, of bisulphate of mercury on phenic acid, disengages too much sulphurous acid; I was therefore constrained to set aside this reagent, which destroyed, in proportion to its abundance, the colouring matter produced. Seeing that it was a case of simple oxidation, and not wishing to introduce nitrogenised bodies, I tried dried arsenic acid; and this is the way the operation may be economically conducted:—A mixture of five kilogrammes of phenic or cresylic acid, or other analogous substances, with three kilogrammes of dried and finely powdered arsenic acid, is heated for twelve hours at 100° C. in an iron cauldron. Stir the mixture frequently with an iron spatula. The coloration appears at the end of about two hours, and increases gradually in intensity as the mixture thickens, with disengagement of aqueous vapour. At the end of the twelve hours raise the temperature to 125° C., and maintain it at this point for six hours; the mixture, at first slightly puffy, becomes pasty and quiet; when all action has ceased, the smell of phenic acid will have totally disappeared. Then add ten kilogrammes of commercial acetic acid at 7°, and heat till the whole is completely dissolved; an excessively dark liquid results; decant this, and exhaust the residue in a cauldron with two litres of acetic acid; filter these acetic liquids, which contain a yellow colouring matter, through cloth. To extract this matter, dilute the liquid with twelve litres of water, and saturate it with chloride of sodium. The colouring matter then precipitates itself under the form of flakes, which, collected on a cloth, are of a pale brown colour. Re-dissolve the precipitate in water, refilter it, and reprecipitate it by chloride of sodium, when it may be considered sufficiently pure. Spread upon porcelain plates on a stove, it quickly dries under the form of brilliantly coloured reddish-brown spangles. The colouring matter dissolves in considerable quantities in cold water, the solution being golden yellow; it is much more soluble in boiling water, from which, on cooling, it deposits reddish-brown plates; it is soluble in alcohol, methylene, and ether; insoluble in benzol; soluble, without alteration, in all acids. Cold concentrated sulpuric acid dissolves it; the addition of water causes no alteration in the solution, and the colouring matter loses none of its primitive qualities. Concentrated or dilute alkaline solutions, alkaline, and earthy carbonates, easily dissolve the colouring matter, forming red salts, which die silk and wool perfectly, from the darkest red to the most delicate rose colour. The solubility of the baryta salt suggests a new way of purifying this colouring matter. By dissolving it in boiling water with twice its weight of freshly precipitated carbonate of baryta, the impurities attach themselves to the excess of carbonate, and the filtered boiling liquid, saturated exactly with sulphuric acid, again filtered, and saturated with chloride of sodium, furnished the colouring matter in an extremely pure state. This pure colouring matter is yellow; it is an acid forming red salts; the circumstances under which it is formed are analagous to those under which picric acid formed. One is the result of oxidation by nitric acid, the other of oxidation by arsenic acid. In each case we have a yellow acid and coloured salts; and the two acids dye yellow without a mordant. Soap has no effect on wools and silks dyed yellow with this acid; the red tint is made very brilliant by soap. It is very possible that this new substance can be used in printing. This colouring matter is not identical with that discovered by MM. Kolbe and Schmidt, though the two bodies have some points in common. For this reason I have felt no hesitation in publishing my researches, without any intention of decrying the substance described by MM. Kolbe and Schmidt.

APPLIED CHEMISTRY.

CONGELATION OF WATER.—Dr. Robinet has addressed a curious communication on the congelation of water to the Academy of Medicine. It is well known that the blocks of ice formed in the sea yield fresh water by liquifaction. When sea-water or any saline dissolution is congealed, the pure water is separated in the form of ice, and there remains a concentrated watery solution of the saline matter. It is thus salt is economically obtained in the north of Europe. To increase the alcoholic strength of wine it may be subjected to artificial cold, whereby the water alone which it contains is congealed and the wine becomes richer in alcohol. By operating in a similar manner manner on potable water. Dr. Robinet has found that it loses nearly all its salts, whether soluble or not. The waters of the lakes of the Bois de Boulogne having been subjected to the operation, the small quantity of calcareous and magnesian salts they contained were eliminated. The purity of the water obtained by this method is such that it may in many cases be used instead of distilled water.

LIST OF APPLICATIONS FOR LETTERS PATENT.

We have adopted a new arrangement of the Provisional Protections applied for by Inventors at the Great Seal Patent Office. If any difficulty should arise with reference to the names, addresses, or titles given in the list, the requisite information will be furnished, free of expense, from the office, by addressing a letter, prepaid, to the Editor of "The Artizan."

Dated July 25th, 1862.

2110. H. A. Jowett—Obtaining motive power.
2111 J & H. Bedgate—Manufacture of fabrics on bobbin net or twist lace machines
2112 J. Anderson—Separating gluten from starch and preparing gluten for food.
2113 P. Robinson— Producing brushing or frictional surfaces.
2114 W. Clark.—Apparatus for decanting wine.
2115 J. Seymour—Apparatus for steering ships.
2116 W. Clark—Rafts or structures applicable to marine and inland navigation.
2117 V. Manzini—Locomotive engines and trains adapted for inclined places of railways.
2118 E. Comfort—Watch protectors.
2119 A. Lahousse—Railway wheels.
2120 F. T. sall—Forks.
2121 T. Sagar—Moulding.

Dated July 26th, 1862.

2122 A. V. Newton—Attaching armour plates to ships.
2123 W. Clark—Extracting silver from ores
2124 J. H. Selwyn—Apparatus employed in paying out and raising electric telegraph cables.
2125 T. Long—Manufacture of open metal work.
2126 R. Low and W. Duff—Producing an adjustable pressure on certain parts of machinery.

Dated July 28th, 1862.

2127 J. Walton and J. Moore — Ventilating and heating Turkish baths, hothouses and buildings of all kinds.
2128. H. Bollinger—Machinery employed in ship-building.
2129 C. W. Eddy—Impeding a channel against the entrance of vessels.
2130 W. Spence—A red colouring matter.
2131 P. S. Devlan—Telegraphic cables.
2132 W. Spence—A blue colouring matter.
2133 T. A. Favrichon—Heating baking ovens.
2134 W. Maugham—Manufacture of effervescent beverages.
2135 T. Cook—Manufacture of envelopes.
2136 A. Noble—Obtaining and treating compounds of alumina.
2137 J. Fourdrinier—Apparatus for removing knots from pulp.
2138 J. Ellis—Washing grain.
2139 F. Selby—Surface condensers.
2140 H. Hedgely—Lamps.
2141 E. Burdett—Combined cart or sleigh.
2142 J. L. Jouillon—Antichloride for paper making.
2143 C. W. Siemens—Gas engines.

Dated July 29th, 1862.

2144 R. Thompson—Lock-stitch sewing machines.
2145 Z. Colburn—Steam pumping engines.
2146 J. Mackenzie—Shaping machines for curvilinear surfaces.
2147 A. Boyle & T. Warwick—Manufacture of the ribs and stretchers of umbrellas and parasols.
2148 E. T. Hughes—Refining the slag from blast, puddling and other furnaces, and the employment of the refined material for mortar, stones, slabs, ornaments, and other similar articles.
2149 P. S Devlan—Composition employed for covering projectiles and the internal and external surfaces of vessels, which is also applicable to the manufacture of tubing and to other useful and ornamental purposes.
2150 J. Norris—Construction of ovens.
2151 C. T. Burgess—Stand for beer and other casks.
2152 G. Waldie—Colour printing.
2153 J. & D. Mapple—Telegraphic apparatus.
2154 E. B. Clark—Manufacture of candles.
2155 M. Henry—Obtaining fibrous materials and paper pulp, treating, cleansing, and scouring fibrous materials and fabrics manufactured thereof, producing soap for the said operations, and obtaining products from liquors used therein.
2156 G. Nock—Safety or moveable self-acting crossing for railways.

Dated July 30th, 1862.

2157 F. C. Warlich—Machinery for dressing and shaping stone.
2158 W. E. Gedge—Apparatus for securing the safety of trains moving on railways.
2159 J. & J. Hyde—Governors for steam engines water wheels, mills, and for other similar purposes.
2160 B. Bailey—Apparatus for cutting chaff and other vegetable matters, which improvements are also applicable to cutting or mowing short grass.
2161 H. White—Shirt collars.
2162 W. Wanklyn—Apparatus for opening and conditioning East Indian and other tightly-compressed cottons.
2163 J. Benyon—Looms for weaving.
2164 G. H. Birkbeck—Preserving timber from decay or destruction.
2165 W. Clark—Gas burners.
2166 T. Holt & F L Stott—Compositions for protecting polished surfaces of iron and steel against oxidation, and for renewing and improving the polish of such surfaces.
2167 W. Norman—Tables and drawers or other sliding receptacles.
2168 J. W. Dixon—Coffee urns.
2169 J. W. Woodford—Machinery for raising or forcing water.

Dated July 31st, 1862.

2170 E. F. Prentiss & R. A. Robertson—Obtaining products from rock oil, coal tar and other like mineral substances in a more or less pure and deodorized state, and the apparatus to be used therefor, and which is also applicable to distillation in general.
2171 W. Weild—Machines for cutting, shaping rolling, drilling, screwing, milling, and fluting metals.
2172 J. & E. Ransom—Mounting mill-stones.
2173 C. Bedells—Manufacture of braces.
2174 G. T. Bousfield—Fluids suitable for burning in lamps and for other uses.
2175 A. V. Newton—Machinery for planing metal.
2176 W. E. Newton—Lubricating compounds.

Dated August 1st, 1862.

2177 J. List—Instruments for obtaining distances and heights, and distances between distant objects, without computation.
2178 J. Sinclair—Arrangements for ventilating and in part applicable for fumigating.
2179 D. T. Lee—Ornamenting surfaces of wood and of papier maché.
2180 G. Haseltine—Apparatus for drying grain, gunpowder, and other granular substances.
2181 G. A. Biddell—Railway crossings.
2182 J. C. On ons—Portable forges.
2183 R & D. Nurse—Annealing pot.
2184 J. E. Marsh—Metal rivets used in joining or securing together parts of boots, shoes, and other articles of leather.
2185 C. H. Slevins & H. Rider—Colliery waggons, tubs, or corves, and in apparatus for tipping or discharging the same.
2186 W. E. Newton—Projectiles for ordnance and small arms, and in the wads or sabôts to be used therewith.
2187 T. G. Webb—Manufacture of flint glass.

Dated August 2nd, 1862.

2188 T. Onion—Rotary steam engines and propellers adapted to propelling vessels in water.
2189 J. Briggs—Manufacture of belts, webs, braids, tapes, laces, and other similar articles produced by weaving, plaiting, or twisting.
2190 J. Gray—Arrangements for cleaning ships' bottoms, and for preventing the fouling thereof.
2191 E. B. Wilson & M. Picard—Manufacture of iron and steel.
2192 C. Warne—Manufacture of linen arabbett.
2193 G. Coles, J. A. Jaques, J. A. Fanshawe—Manufacture of grinding and polishing tools and surfaces.

Dated August 4th, 1862.

2194 A. & E. M. Denny—Manufacture of bacon.

Dated August 5th, 1862.

2195 S. Simon—Ornamenting ladies and childrens' slippers.
2196 J. Thomas—Self-adjusting screw wrench.
2197 J. Higgin—Substitute for cow dung used in printing and dyeing textile fabrics or yarns.
2198 J. Townsend—Damping cotton and other fibrous materials and fabrics, in preserving the same from mildew, and in preserving size or stiffening from decomposition.
2199 W. Clark—Purification of water and apparatus employed therein.
2200 M. J. Roberts—Apparatus for spinning and preparing wool and other fibrous substances.
2201 J. R. Nicholl—Apparatus for utilizing and disposing of the sewage of towns and villages.
2202 A. Priestley—Apparatus applicable to locomotive railway engines and carriages for distributing sand upon the rails to give adhesion to the driving and brake wheels of such engines and carriages.

Dated August 6th, 1862.

2203 W. W. Burdon—Reducing wood fibres to pulp.
2204 J. C. Richardson—Cleaning cotton waste.
2205 M. C. Sinibaldi—Manufacture of chains, and the apparatus employed therein.
2206 W. G. Valentin & F. Levick—Generation of combustible gases for lighting and heating purposes, and the mode of applying such gases to the manufacture of iron, glass, and other processes in the arts where great heat is required.
2207 F. Nauheim—Ornamenting of boots, shoes, and goloshes.
2208 J. H. Johnson—Construction of armour plates for ships and forts, and applicable to other like purposes.
2209 M. A. F. Mennons—Self-inking hand stamp.
2210 C. Culling—Fire-arms.
2211 A. Thiriez—Machine for glossing and glazing all thready fabrics.

Dated August 7, 1862.

2212 François Henry Marie Côme Damiens Chevalier de Fenis de Lacombe—Lighting towns or other localities, and of ventilating, warming, and providing the same with water.
2213 J. H. Johnson—Blast furnaces.
2214 R A. Brooman—Improvements in ships and vessels in order to prevent injury from collisions.
2215 R. A. Brooman—Improvements in covering ships and vessels built of wood, or iron ships with a backing of wood, before placing iron, steel, or other armour plates on such ships and vessels.
2216 W. Clark—Improvements in the rig, spars, and sails of ships and other vessels.
2217 B Coombe—Machinery for clearing and decorticating wheat and other grain.
2218 R. W. Ralph—Reaping machines.

Dated August 8th, 1862.

2219 E. Hall—Apparatus for preparing foreign grain for grinding.
2220 J. Siron—Beverage used as a cure from several illnesses and distempers.
2221 F. M. Jennings—Composition for coating ships' bottoms to prevent fouling.
2222 J. Whipp—Apparatus for cleaning articles of ornament and jewelry.
2223 N. J. Amies — Bearings, "journals," and "steps," employed in machinery, and for carriage and other axles.
2224 R. A. Brooman—Repeating fire arms.
2225 W. Clark—Signalling.
2226 E. Humphrys—Steam engines.
2227 Apparatus for preparing, spinning, and weaving cotton and other fibrous materials, parts of which are applicable to other mechanism, in which an uniform or variable rotary motion is required.

Dated August 9th, 1862.

2228 J. Macintosh—Obtaining and applying motive power.
2229 R. Fowler—Manufacture of woven, plaited, knitted, and other fabrics.
2230 G. Haseltine—Carriage wheels.
2231 Sir J. S. Lillie—Carriage ways and footways.
2232 J. J. H. Gebhardt — Fastening for purses, pocket books, needle books, ladies' companions, instrument cases, and other similar articles.
2233 A. J. Moreau & A. E. Ragon—Mode of and apparatus for treating bituminous and carbonaceous substances for the purpose of obtaining the various products, volatile liquid and solid, which they contain, and also in the treatment and application of such products.
2234 A. J. Moreau & A. E. Ragon—Manufacture of gas and coke.
2235 T. De la Rue—Manufacture of pigments and writing inks.
2236 G. T. Bousfield—Manufacture of hat bodies.

Dated August 11th, 1862.

2237 H. B. Barlow—Machines for weaving, warping, sizing, and dressing.
2238 H. Fenton & W. Stubbs—Telegraph wires.
2239 W. E. Newton—Machinery for compressing powder for cartridges.
2240 J. Goodfellow—Steam or water engines.
2241 T Holdsworth & J. Crossley—Machinery for warping, scouring, sizing, stretching, measuring, cooling, drying, and beaming yarns for weaving.
2242 W. Clark — Carriage for conveying sugar moulds in sugar refineries.
2243 N. J. Aimes—Manufacture of bearings or steps employed in machinery and railway and other carriages, and in a composition to be applied thereto.
2244 J. Lancelott — Manufacture of ornamental chains from sheet metal.
2245 M. H. Champion—Self closing buttons fastening without thread or needles.
2246 W. E. Gedge—Construction of ladders.
2247 J. Combe & J. H. Smalpage—Machines for winding cops, and apparatus for holding and receiving such cops when used for warps or sewing thread or other purposes.
2248 H. Donald—Machinery for shearing, punching, and riveting metals.
2249 A. J. Martin, J. Goss, & J. Bush—Apparatus for distillation.
2250 R. Giesty—Scarfs or cravats.

Dated August 12th, 1862.

2251 W. Macnab—Steam boilers and apparatus for feeding the same, and for effecting circulation therein.
2252 J Ramsbottom & G. Hacking—Apparatus for measuring and registering the flow of water and other fluids.
2253 J. Dixon—Treating zinc ores and solutions of zinc to obtain zinc therefrom.
2254 J. Dickson—Treating ores and solutions of lead to obtain lead therefrom.
2255 L. Serbat—Lubricating machinery
2256 C. A. Wheeler — Machinery for perforating paper.
2257 A. Delarue—Compositions for preventing and removing incrustation in boilers.
2258 C. M. Westmacott—Cements.
2259 J. Langran—Apparatus for driving agricultural machinery.
2260 J. F. J. Leblond—Sewing machines.
2261 A. B. Childs—Machinery for cutting veneers.
2262 C. Sengry—Smoking pipe, which may also be adapted as a tube for smoking cigars.
2263 G. Sanders—Domestic fire escapes.
2264 J. Bower—Railway sleepers

Dated August 13th, 1862.

2265 J. Dickson—Manufacture of chlorine for commercial purposes
2266 J Dickson—Obtaining sodium from certain sources of that metal
2267 J. Cooper—Valves and buckets for pumps, and valves or cocks for other uses.
2268 J. Smith & J. S Rayment — Apparatus for generating steam and for regulating its flow.
2269 J. R. & F. C. Tussaud—Treatment of representations formed from wax or from compositions of wax with other matters.
2270 C. W. Smith, W. Mould, S. Cook, & W. H. Hacking—Looms for weaving.
2271 W. L. Boyle—Construction of chairs and foot stools for the use of dentists, and chairs, couches and beds for invalids.
2272 J. Peters—Hydraulic cement
2273 H. Twelvetrees—Rat and mice traps.
2274 G. Turner—Fastening armour plates of ships.
2275 L. D. Verstraet & E. M. Olivier—Manufacturing carbonate of soda by the application of sulphuret of sodium.
2276 L. Galli—Apparatus for propelling vessels
2277 W. Schnell—Extracting sulphur and sulphurous acid from the oxy-sulphuret of calcium, which is contained in the residues or waste material obtained in the manufacture of soda.
2278 J. H. Johnson—Carts and other vehicles.

Dated August 14th, 1862.

2279 E. J. Dagnall—Tray or receptacle adapted for wash-hand stands for holding tooth brushes, tooth powder, and nail brushes.
2280 A. Walker—Instrument to determine or ascertain the depth of water and the distance a ship has run.
2281 J. Irvine & J. W. Hand—Rifle rest.
2282 J. K. & E. Hoskins—Manufacture of plain and ornamental metallic pillars for bedsteads, cots, couches, and tables.
2283 G. Welch — Inkstands, metallic pens, and penholders.
2284 C. E. Wilson—Buckle fastenings for braces and belts
2285 W Beatson—Manufacture of stoves.
2286 G. White, F. Buckland, & C. Rees—Manufacture of water closets.
2287 D. P. Marques—Apparatus for cleaning the bottoms of ships and vessels.
2288 H. R. Passey & L. Niman — Cigar tube or holder.
2289 J. Petrie—Machinery for blowing and exhausting air.
2290 W. J. Curtis—Apparatus for ascertaining the the fares and earnings of public vehicles.
2291 J. Hopwood—Machinery for collecting fibrous material and dirt from the carriage boards and roller beams of mules.
2292 J. Hearn—Apparatus or appliances to be used in the treatment of hospital and other patients.
2293 W. Soutter—Apparatus for raising and planishing metals.
2294 W. B. Herapath—Decolorizing solutions of sugar, and also vegetable juices containing sugar.
2295 J. S. Blockey — Manufacture of colouring matters
2296 W. B. Herapath—Treating crystallizable sugar to render it more suitable for fermentation and conversion into alcohol and vinegar.
2297 C. E. Spagnoletti—Apparatus for signalling trains on railways.

Dated August 15th, 1862.

2298 M. A. F. Mennons—Apparatus for the production of sealing wax impressions.
2299 J. Barclay—Machinery for the manufacture of nails
2300 A. Shopard—Obtaining light.
2301 T. Carvin—Screw propellers.
2302 T. F. Kirby—Garments for gentlemen's and ladies' wear.
2303 J. Newman—Machinery for the manufacture of metallic tubes.
2304 J. Carter & J. Maher—Power looms.
2305 J. H. Johnson—Electro-magnetic time-keepers.

Dated August 16th, 1862.

2306 R. Barclay—Chronometers.
2307 H. Garside—Marking, etching, or engraving on cylindrical and other surfaces.
2308 C. H. J. W. M. Liebmann—Machinery for finishing textile fabrics.
2309 T. Knowles & W Robinson—Racks for window blinds
2310 M. Iturriaga—Fire-arms.
2311 S. A. Bell & T. Higgins—Dipping lucifer matches.

Dated August 18th, 1862.

2312 G. Chapman—Reaping machines.
2313 F. Barnett—Lamp for street lighting.
2314 J. Cimeg—Depositing silver and other metals on fabrics and other materials.
2315 J. T. Oakley—Heating stoves for drying.
2316 W. E. Newton—Connecting plates, sheets, or slabs of metal, and fastening the same on to framing applicable to armour plating for ships, vessels, or batteries, and to roofing.
2317 J. Briere—Continuous self acting condenser.
2318 H. Boetius—Fire-proof materials.
2319 H. Melton—Hats and caps.

Dated August 19th, 1862.

2320 T. Wilkinson—Apparatus for singeing pigs.
2321 V. F Cleuet—Self-acting apparatus for supplying boilers with water.
2322 G. H. Dembinski—Motive apparatus, and processes proper for giving to it a continuous motion and unlimited strength.
2323 S Bouctier—Flax, tow, and hemp spinning.
2324 W. J. Hoyle & J. Proven—Mechanism for supplying lubricating matter to the cylinders of steam engines
2325 T. H. Falkiner—Permanent way of railways.

Dated August 20th, 1862.

2326 J. G. Tongue—Extracting the natural wax or fatty matters from wool, hair, or other animal or vegetable substances containing the same.
2327 W. Whittle—Nails and spikes.
2328 C. Callebaut—Sewing machines.
2329 H. Whittaker—Healds or heddles.
2330 W. H. Hutchinson—Ammonia and the prussiates of potash or soda.
2331 J. Standish & J. Gooden—Machinery used in the preparation of cotton, wool, or flax to be spun.
2332 S. Wilkes—Attachment for door knobs.
2333 C. Chinnock—Cork screw.

Dated August 21st, 1862.

2334 S. J. Paris & W. Bate—Alphabetical electric telegraphs.
2335 J. C. Schemmann—Manufacture of steel.
2336 M. Wilkinson—Carding engines.
2337 G. Davies—Governors for steam engines.
2338 T. Clements, P. Llewellin, J. Llewellin, & J. W. James—Self-acting lubricator for lubricating various parts of steam engines.
2339 A. Boubée—Casting or moulding glass and imitating precious stones or marbles.
2340 A. Boubée—Veil protector.

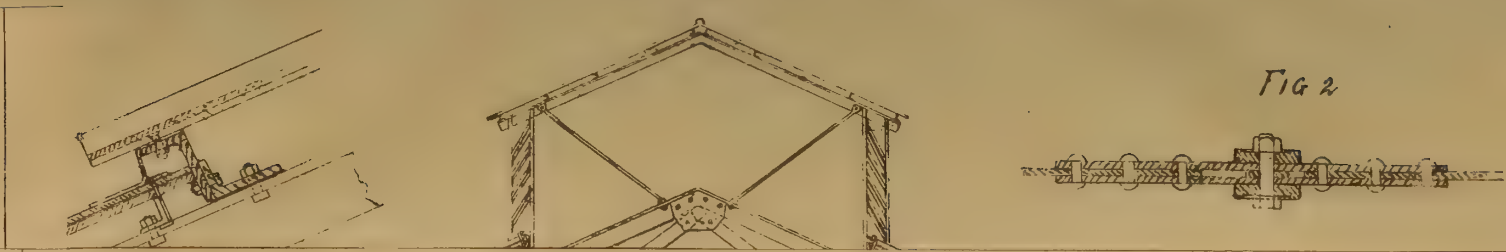
Dated August 22nd, 1862.

2341 S. F. Griffin—Distillation of petroleum.
2342 A. Whytock—Making boxes.
2343 C. Monson—Repeating rotary engine.
2344 W. Barrett—Railway sleepers and chairs.
2345 E. S. Ritchie—Mariner's compass.
2346 J. Mackay—Soap powder.
2347 R. Harrington—Umbrellas and parasols.
2348 H. Twelvetrees — Washing powders, soap powders, and cleansing crystals.
2349 D. Moore—Breech-loading fire-arms.
2350 G. Bottomley—Expressing moisture from pulpy or solid substances.
2351 D Moore—Revolving fire-arms.
2352 W. Carwood, W Bonz, and C. Colwell—Propelling ships and other vessels.
2353 T. Wood—Slide valves of steam engines.

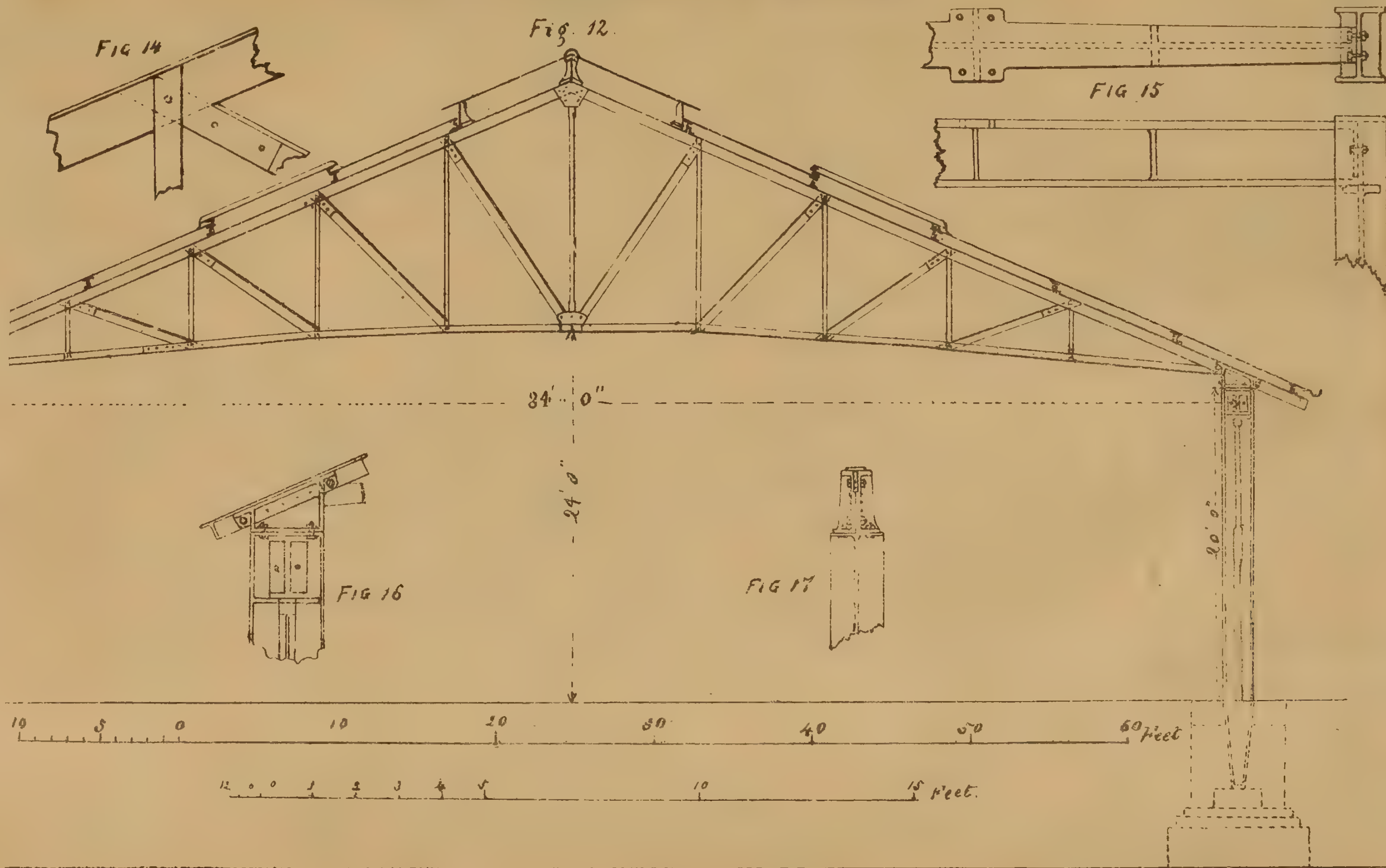
Dated August 23rd, 1862.

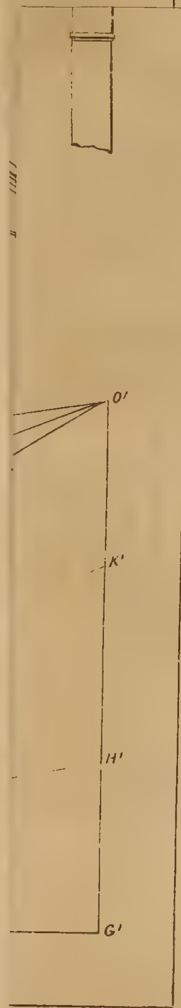
2354 J. Edwards—Permanent way of railways.
2355 F. T. Moison—Cleaning organic matter.
2356 J. Hinks and A. Dixon—Brooms and brushes.
2357 M. K. Angelo—Manufacture of shell-inc.
2358 M. Henry—Stuffing boxes and their packings.
2359 C. H. Roeckner—Drawing off large bodies of water.
2360 W. E. Newton — Treating fermentable substances for brewing and distilling.

ROOF OVER PAPER-MILL DARTFORD.

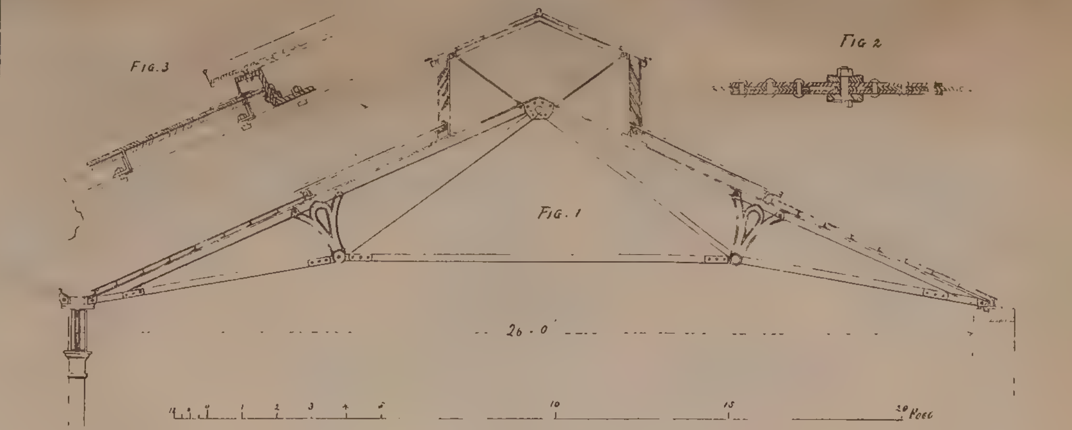


ROOF AT CHATHAM DOCK-YARD.





ROOF OVER PAPER-MILL DARTFORD.



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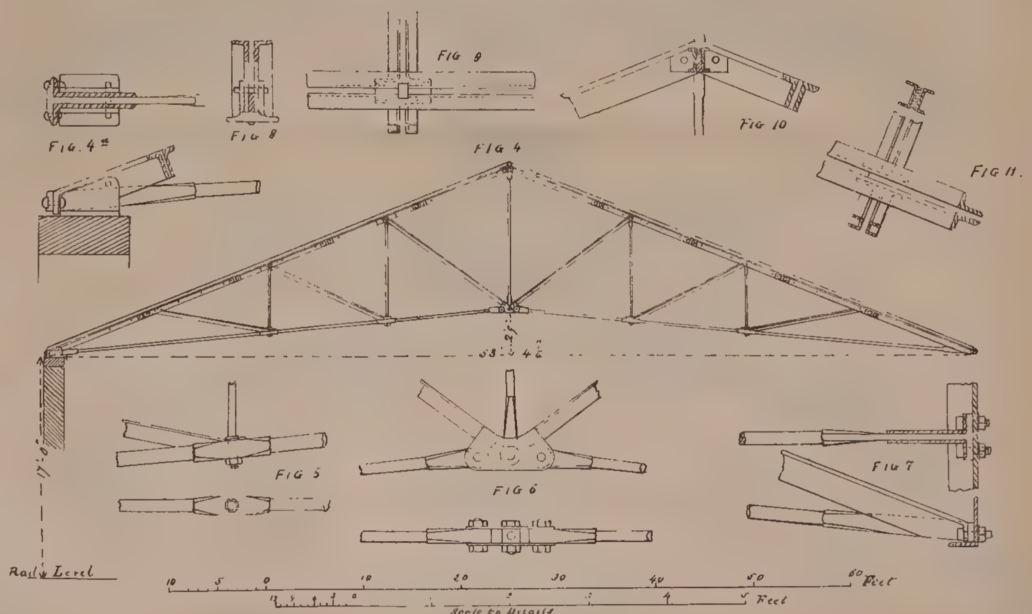
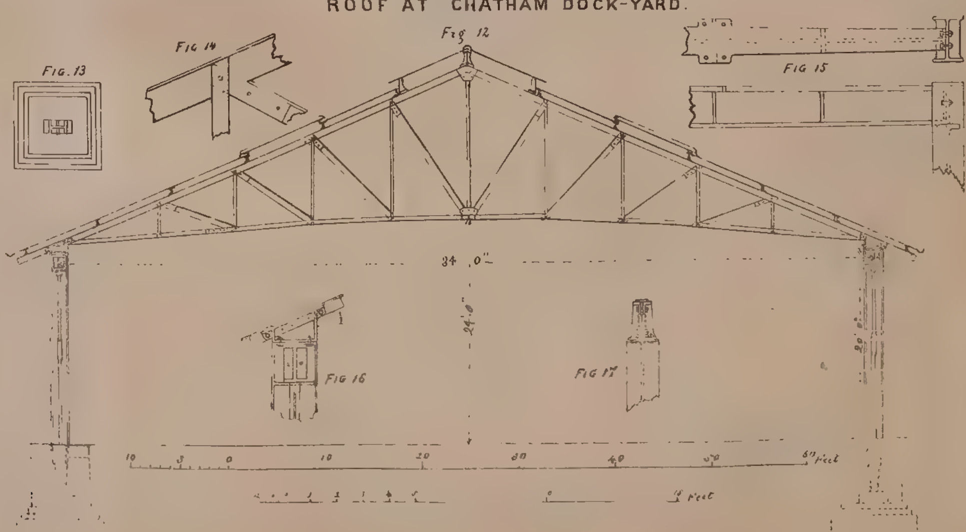
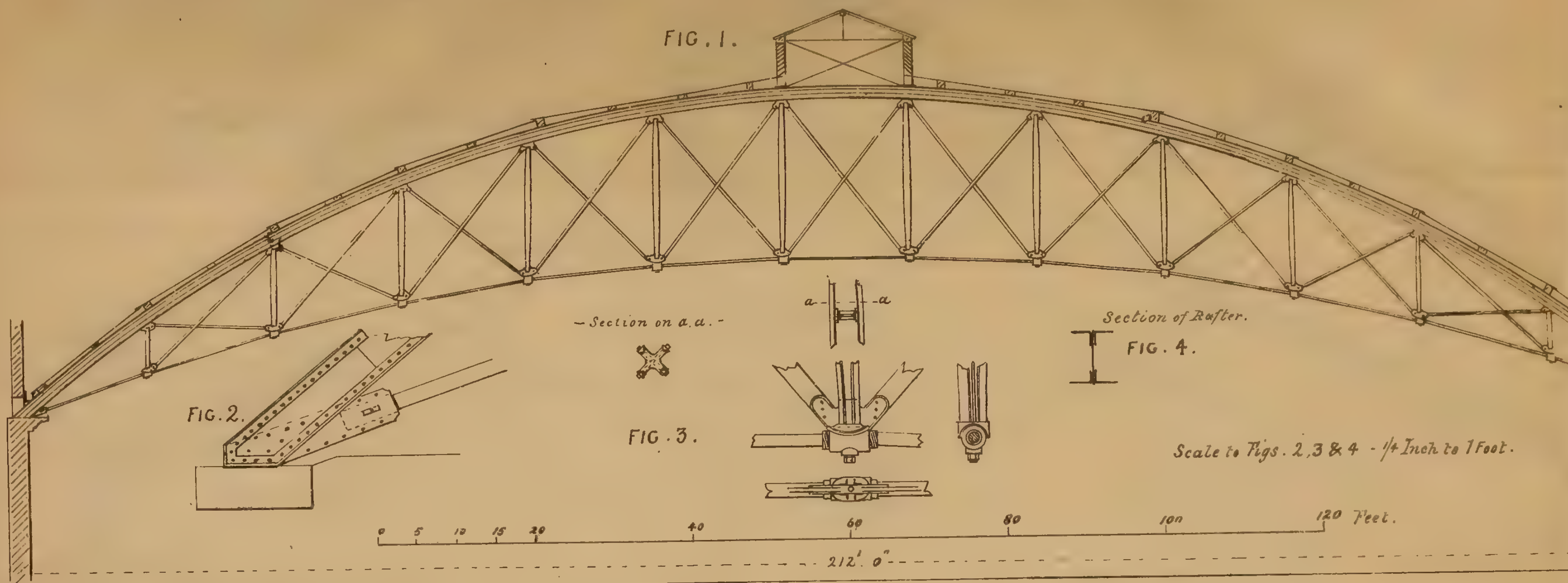
BATTERSEA LOCOMOTIVE WORKS.



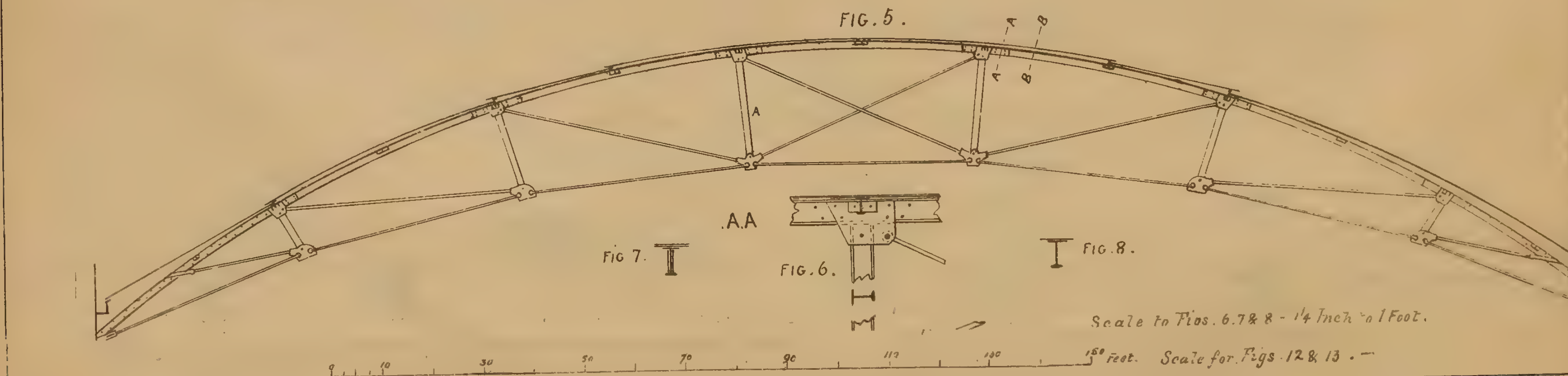
ROOF AT CHATHAM DOCK-YARD.



ROOF OVER NEW STREET STATION, BIRMINGHAM.



ROOF OVER LIME STREET STATION, LIVERPOOL.



W. Smith. C.E. direx.

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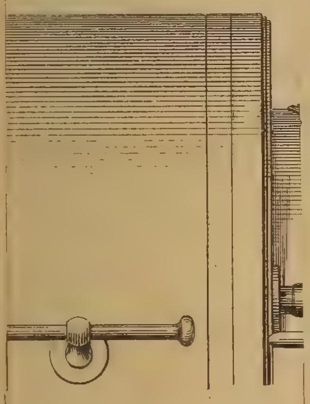

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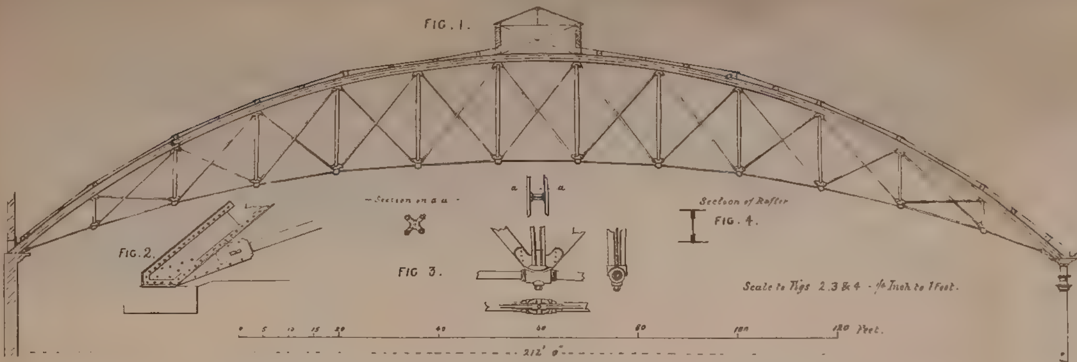
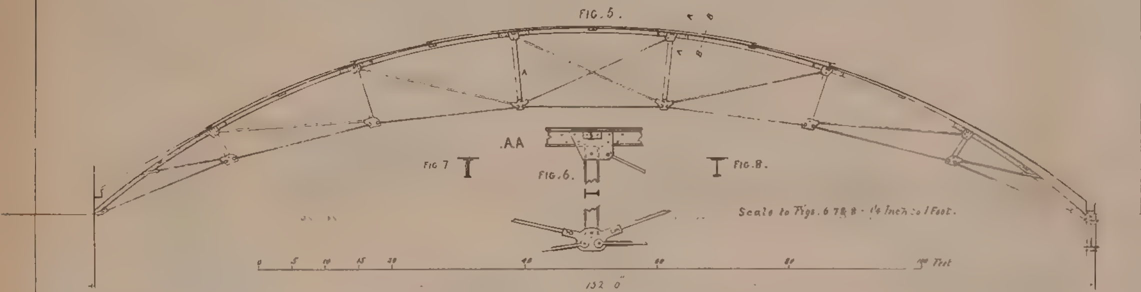
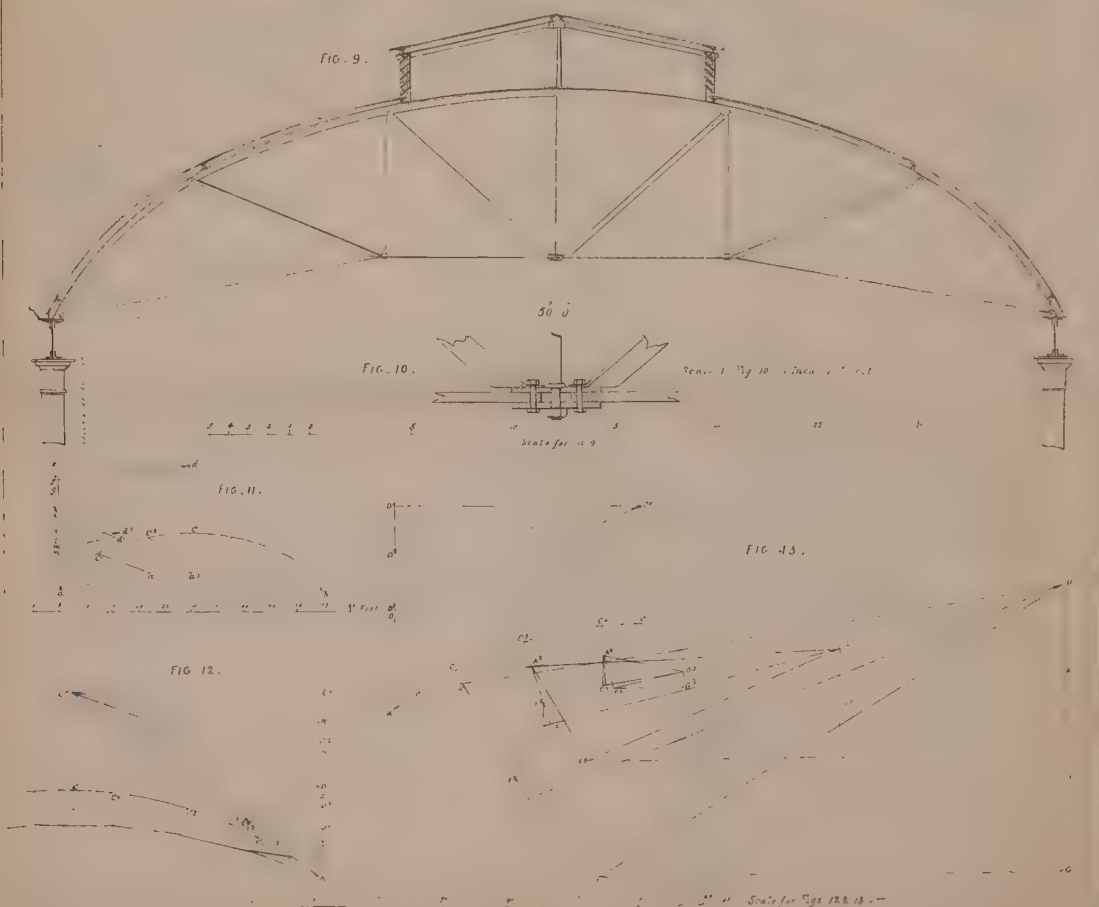
ROOF OVER NEW STREET STATION. BIRMINGHAM.



ROOF OVER LIME STREET STATION, LIVERPOOL.



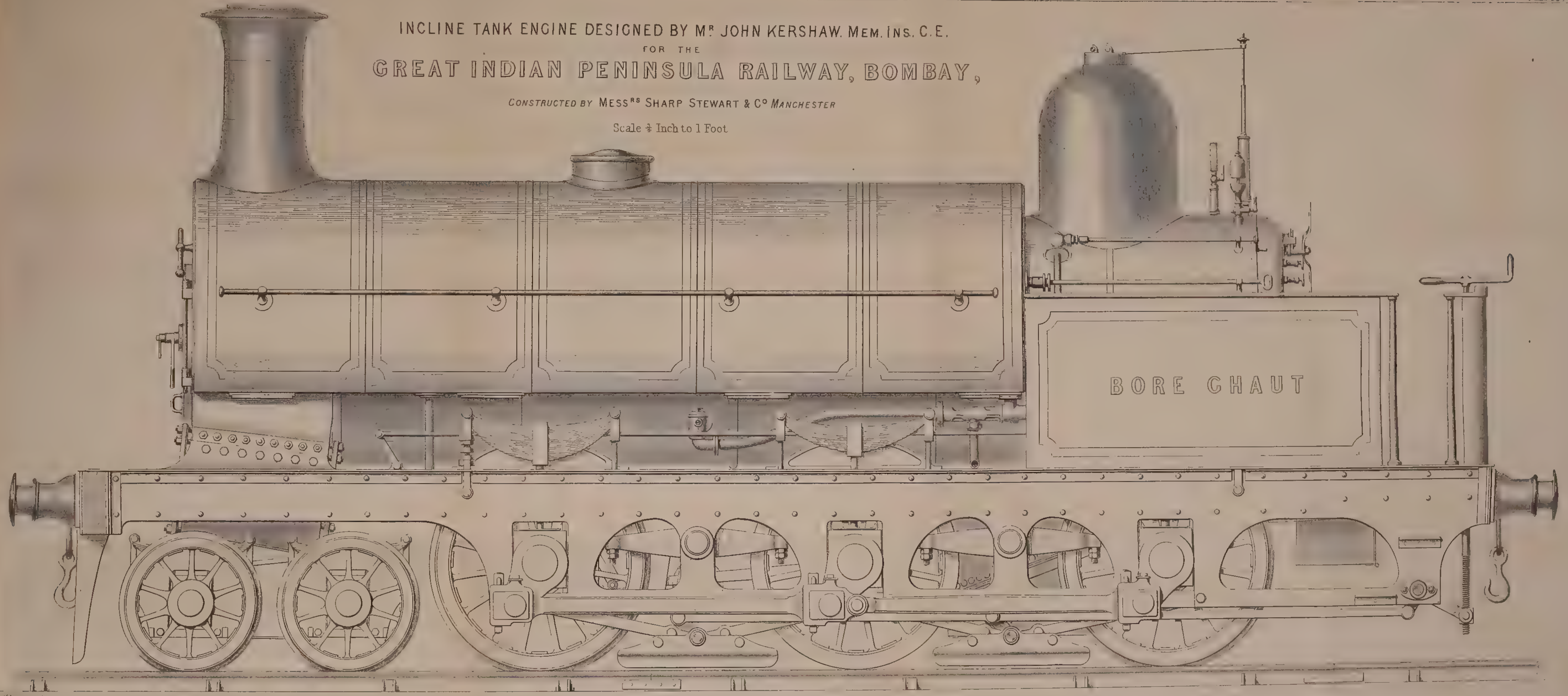
ROOF OVER FAIRBAIRN'S BOILER YARD.



INCLINE TANK ENGINE DESIGNED BY MR JOHN KERSHAW. MEM. INS. C.E.
FOR THE
GREAT INDIAN PENINSULA RAILWAY, BOMBAY,

CONSTRUCTED BY MESSRS SHARP STEWART & CO MANCHESTER

Scale ¾ Inch to 1 Foot



THE ARTIZAN.

No. 238.—Vol. 20.—OCTOBER 1, 1862.

INCLINE TANK ENGINES FOR THE GREAT INDIAN PENINSULA RAILWAY, BOMBAY.

Designed by Mr. John Kershaw, Mem. Inst. C.E.

(*Illustrated by Plate No.* 224.)

Our plate for this month represents the side elevation of one of a class of engines—designed for working very steep gradients combined with sharp curves—now in course of construction by Messrs. Sharp, Stewart, and Co., and intended to work upon the Bhore Ghaut and Thull Ghaut inclines of the Great Indian Peninsula Railway. Of the two inclines the Bhore Ghaut is the heavier, being longer, and attaining a greater altitude than any incline in Europe. It is 15 miles 68 chains in length, and a total rise of 1851 feet. The average gradient is 1 in 37 for 4 miles 48 chains, and 1 in 40 for 5 miles 6 chains.

The following dimensions indicate the large power and good distribution of weight on the wheels of the engine.

The cylinders are of 20 in. inside diameter, and 24 in. stroke. There are 10 wheels, 6 of 52 in. diam., all coupled together and having between them to the outside springs compensating levers; the driving wheels are without flanges, and of the tyres turned parallel. The four leading wheels under the bogie are each 33 in. diam., and carry the front part of the engine. The bogie is constructed on a plan admitting of both radial and lateral movement through block and quadrant, by means of which the engine will be able to traverse curves of 500 feet radius with facility, without cutting the flanges of the wheels, or straining the framing in any way.

The tyres of all the wheels are of Krupp's steel, secured to the irons on Mr. Beattie's system.

The inside and outside frames are continuous and straight for their whole length, and of great strength; the inside frames being 1 in. thick by 12 in. in its least depth, worked out of the solid. The outside frames are $4\frac{5}{8}$ in. thick, of the usual sandwich form. Both inside and outside frames are very strongly cross-stayed, so that the whole framing can withstand the severe duty which engines of this class and power are called on to perform.

The boiler, fire-box, and smoke-box, are all flush, of 4 ft. 8 in. outside diameter, constructed entirely without angle iron, and thus possessing very considerable strength and simplicity. With the object of preventing priming, liable to an engine traversing inclines of 1 in 37, owing to the change of the water level, a capacious dome is placed on the centre of the fire box from which the steam is taken.

The inside fire box, of copper, has a longitudinal midfeather, the bottom sloping upwards at a moderate angle to the back of the fire-box, so as to allow the wheel base to be reduced, and the weight on each pair of coupled wheels to be made as nearly as possible.

Although the size of the boiler would allow of a large number of tubes being used, it is considered that greater evaporative efficiency will be obtained by increasing the proportion of direct to indirect heating surface, and also by giving more than usual freedom for the escape of steam amongst the tubes. Hence there are only 200 tubes of 2 in. diam., giving a surface of 1293 square ft., which, with 150 square ft. of fire-box surface, gives a total of 1443 square ft. of evaporation surface, and a boiler and fire-box of large proportional steam and water room.

With the object of obtaining all possible efficiency and economy in working, every well-ascertained improvement is adopted; the boiler is fed by one of Giffard's injectors and one pump, the injector being alone able to supply the boiler either when the engine is drawing its heaviest load, or when standing still. The descent of a long incline of 1 in 37 with heavy trains requiring ample brake power, four sledge brakes, one between each pair of coupled wheels, are carried from the inside and outside frames, and arranged so as to transfer the whole weight on these wheels (about $37\frac{1}{2}$ tons) to the rails through the sledges, thus entirely saving the usual rapid and costly destruction of the tyres, whilst using a brake of the greatest retarding power.

The haulage of useless weight is saved, and additional tractive force is obtained, by dispensing with the tender and substituting a saddle tank containing 1050 gallons. This tank covers the smoke-box, the boiler, and part of the fire-box. The coal-boxes are placed on either side of the fire-box.

This engine, in working order, will weigh above 49 tons, and will be able to draw a minimum train of 200 tons at the rate of 15 miles per hour, over either the Bhore Ghaut or Thull Ghaut inclines.

USEFUL NOTES AND FORMULÆ FOR ENGINEERS.

(*Continued from page* 197.)

SECTION V.

Friction is that force which acts between two bodies in contact, in the direction of a tangent to the surfaces of contact, tending to oppose the sliding of one body over the surface of the other.

Friction is of two kinds—the friction of rest and the friction of motion; it may also operate in three different ways, as a means of giving stability to structures, as a means of transmitting motion, and as a means of retarding motion; it will, however, be here considered only as a means of giving stability to structures.

Before investigating the laws of friction, we will point out the difference between solid and fluid friction; the former depends upon the pressure without regard to the extent of the surfaces of contact, while the latter depends solely upon the extent of the surfaces of contact; it is evident that when unguents are used to modify the friction between two surfaces, the friction will be regulated by the laws of solid or fluid friction, according to the amount of unguent used.

Law of Solid Friction.

The amount of friction between two surfaces, which tend to slide upon one another, depends upon the force with which those surfaces are pressed together, without regard to the extent of the surfaces of contact, the condition of the surfaces remaining the same, that is to say, of the same material, and uninjured by the pressure; to maintain the last condition, the pressure per square inch, on the surfaces of contact, must not reach the limit of the resistance to crushing or abrasion of the material. From the above it is evident that the amount of friction between any two bodies, subject to the above conditions, may be computed by multiplying the force with which the surfaces are pressed together by a co-efficient, which depends upon the material of which the surfaces are composed, and the condition of those surfaces.

Or if C = co-efficient of friction,
P = pressure, and
F = force of friction,

$$F = C\,P$$

ANGLE OF REPOSE.

Let A B (Fig. 28) represent any solid surface, placed at an inclination to the horizon, and D a solid body in contact with it.

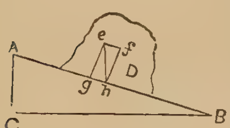


Fig. 28.

Let $e\,h$ represent the direct vertical pressure, exerted by the body D, it will be resolved into two forces, one equal to $e\,g$, acting perpendicularly upon A B; the other, equal to $e\,f$, acting in the direction of a tangent to A B, and, therefore, tending to cause D to slide upon A B.

Let $e\,f = t$ = tangential force.
$e\,g = P$ = normal pressure on A B.
$e\,h = v$ = vertical pressure.
$a = \angle g\,e\,h = \angle e\,h\,f$ = angle of obliquity.

$$P = v \cos. a \quad . \quad . \quad . \quad (1)$$

$$t = v \sin. a = P \tan, a \quad . \quad . \quad . \quad (2)$$

Draw A C at right angles to the horizontal line C B, then will A C be parallel to $e\,h$, therefore

$$\angle C A B = \angle A h e$$

therefore the angle C A B is the complement to the angle a, but C A B is also the complement to A B C, because A C B is a right angle, therefore,

$$\angle A B C = a$$

If the tangential force t be not greater than C P, it will be balanced by the friction which will be equal and opposite to it, but the friction exceeds C P; therefore, if t be greater than C P, the friction will be overcome, and the body D will slide upon A B. The condition that t shall not be greater than C P, is equivalent to the condition that $\frac{t}{P}$, or tan. a, shall not exceed C, the co-efficient of friction.

Hence it follows that the greatest angle of obliquity of pressure between two planes, which is consistent with stability, is the angle whose tangent is the co-efficient of friction.

This angle is called the angle of repose, and is denoted by Φ; it is the greatest inclination of a plane to the horizon upon which a block of a given substance will remain at rest.

In a structure composed of pieces, with plane joints resting upon subjacent pieces, it is necessary to the stability of the structure that the obliquity of pressure should at no joint exceed the angle of repose.

This case applies to structures of masonry, brickwork, &c.

The stability of walls, subject to oblique stress, will be fully investigated hereinafter, wherefore we will only observe in this place that the obliquity of the resultant of the forces, produced by the pressure acting upon the face of the wall, and by the weight of the wall, must in no case make an angle with the joint upon which it acts, less than the complement to the angle of repose for the material of which the wall is constructed.

SECTION VI.

In this section we shall treat of a class of structures which are subject to strains which do not tend so much to destroy the material of which the structure is formed as to displace it, and although the moments of strain are in many cases similar to those which we have already considered, we yet deemed it desirable to separate these from the foregoing structures on account of the moments of resistance being of a different nature; in most cases the structure resists the strains by its weight, sufficient cohesive strength only being required to hold the material together, and prevent its being ruptured by its own weight.

The materials used in these structures are usually brick, stone, gravel, &c.

STABILITY OF TOWERS AND CHIMNEYS.

Let Fig. 29 represent a chimney shaft which is subject to the action of the wind, and let it be required to find the strain and stability with regard to the section A B. The force of the wind will tend to overturn the shaft, as shown by the dotted lines.

Let A = area of vertical diametral section A B $c\,d$.
P = pressure of wind per unit of surface.
h = Height of centre of gravity of diametral section from A B.
P = total pressure on shaft.
M = moment of pressure at A B.

then for square chimneys,

$$P = p\,A$$

$$M = P\,h = p\,A\,h$$

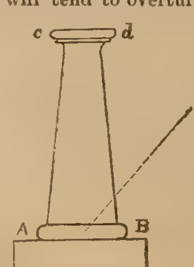


Fig. 29.

and for round chimneys.

$$P = \frac{p\,A}{2}$$

$$M = \frac{P\,h}{2} = \frac{p\,A\,h}{2}$$

To find the stability of the shaft, we must multiply its weight by the leverage with which it acts; this leverage is evidently equal to the horizontal distance of the centre of gravity of the shaft, from the edge on which it would revolve if overturned, which is the edge opposite the side of the shaft which is subject to pressure,—

Let S = moment of stability.
W = weight of a cubic foot of the material.
n = content of structure in cubic feet.
d = horizontal distance of centre of gravity of the structure from the edge on which the shaft would revolve in overturning.

then,

$$S = W\,n\,d$$

but S must never be less than M, hence to find the least value of n we have, for a square chimney,

$$p\,A\,h = W\,n\,d$$

$$\therefore n = \frac{p\,A\,h}{W\,d}$$

and

$$d = \frac{p\,A\,h}{W\,n}$$

For a round chimney shaft,

$$n = \frac{p\,A\,h}{2\,W\,d}$$

$$d = \frac{p\,A\,h}{2\,W\,n}$$

In practice, the strength should greatly exceed the above, when the latter is taken at the actual force exerted by the wind, which, at a maximum in this country, is about 30 to 40 lbs. per square foot; the stability of the shaft should, therefore, be equal to about 60 to 70 lbs. pressure per square foot.

The weight of brickwork varies from 100 lbs. per cubic foot to 120 lbs., according to the quality of bricks and method of laying them.

STABILITY OF RETAINING WALLS.

Let A B C D (Fig. 30) represent a portion of a reservoir wall, one foot in length, subject to the pressure of water, of which the level is at g, and E F any section, in which we require the centre of resistance.

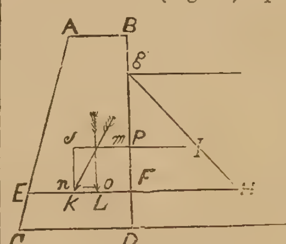


Fig. 30.

The pressure upon the surface g F will be equal to the weight of a triangular prism of water, one foot in length, the triangle G F H representing the side of the prism, F H being drawn at right angles to B D, and equal to the depth of the section E F below the surface of the water; if the wall is vertical on the side B D, this depth is equal to g F.

From I the centre of gravity of the triangle G F H, draw I P perpendicular to g F, then P will be the centre of pressure.

If we consider the surface B D as vertical, and call

B F = x
B G = h
w = weight of a cubic foot of water.

the pressure at P,—

$$= w\,(x - h)\,\tfrac{1}{2}\,(x - h) = \frac{w}{2}\,(x - h)^2$$

Draw m L vertically through the centre of gravity of the section A B F E, produce I P, and make m J equal to the pressure at P, and let m O represent the weight of the part A B F E of the wall; complete the parallelogram J m L k, and $m\,k$ will be the resultant of the two forces, the pressure at P and weight of the wall, k being a point in the line of resistance.

If A B = a, C D = b

W = weight of a cubic foot of the wall,

then,

$$m D = \frac{W}{2}\left\{2\,a\,x + x\,(b - a)\right\}$$

Let $k\,L = y$

By similar triangles,

$$\frac{k\,L}{L\,m} = \frac{m\,J}{J\,n}$$

but

$$k\,L = y$$
$$L\,m = \tfrac{1}{3}\,(x - h)$$
$$m\,J = \frac{w}{2}\left(x - h\right)^2$$
$$J\,n = \frac{W}{2}\left\{2\,a\,x + x\,(b - a)\right\}$$
$$\therefore \frac{y}{\frac{1}{3}\,(x - h)} = \frac{\frac{w}{2}\left(x - h\right)^2}{\frac{W}{2}\left\{2\,a\,x + x\,(b - a)\right\}}$$
$$\therefore y = \frac{w\,(x - h)^3}{3\,W\left\{2\,a\,x + x\,(b - a)\right\}}$$

let the ratio of the specific gravities of the fluid and the wall, or

$$\frac{W}{w} = r,$$

then

$$y = \frac{(x - h)^3}{3\,r\,\left\{2\,a\,x \times x\,(b - a)\right\}}$$

To prevent any course of stones from slipping on the subjacent course, it is necessary that the inclination of $m\,k$, to the perpendicular to the line of contact at k, be less than the angle of repose ϕ, that is, when,

$$\tan.\,\phi > \frac{(x - h)^2}{3\,r\left\{2\,a\,x \times x\,(b - a\right\}}$$

STABILITY OF EARTHWORKS.

The slope of cuttings and embankments should never exceed the angle of repose, for, although a slope may be made artificially, having a greater inclination, the particles being held together by the cohesion of the material, the cohesion will be gradually destroyed by the action of the air and frost, and the earth will continue to slip down until the angle of repose is attained.

The angle of repose is found by observing the natural slopes of embankments of each description of earth.

PRESSURE OF EARTH.

Let A B (Fig. 31) represent the surface of a wall sustaining the pressure of a mass of earth, whose surface C D is horizontal.

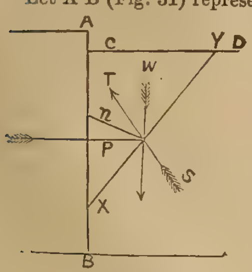


Fig. 31.

Let P represent the resultant of the pressure sustained by any portion C X of the wall, the cohesion of the earth and its friction on the wall being neglected.

Let X Y be the direction in which the earth, supported by C X, tends to yield, so that if C X were removed, rupture would take place along this section, and C X Y be the portion of the earth that would fall. Then the weight of C X Y is supported by the resistance P, and by the resistance of the surface X Y on which it tends to slide.

Suppose, now, that the mass is on the point of sliding down the surface X Y, the pressure P being that only which is sufficient to support it; the resultant S T will be inclined to S n, the normal at an angle equal to the angle of repose, between any two contiguous surfaces of the earth.

Resolving the pressure on P, we find,—

$$P = W\,\frac{\sin.\,W\,S\,T}{\sin.\,P\,S\,T}$$

where W equals the weight of the mass C X Y,

But $W\,S\,T = W\,S\,N - T\,S\,n = C\,Y\,X - T\,S\,n,$

and if $C\,X\,Y = \alpha$

$$W\,S\,T = \frac{\pi}{2} - \alpha - \phi$$
$$P\,S\,T = P\,S\,n \times T\,S\,n = \text{to}\ \alpha + \phi$$
$$\therefore P = W\,\frac{\sin.\left\{\frac{\pi}{2} - (\alpha + \phi)\right\}}{\sin.\,(\alpha + \phi)}$$
$$= W\,\frac{\cos.\,(\alpha + \phi)}{\sin.\,(\alpha + \phi)} = W\cot.\,(\alpha + \phi)$$

If $C\,X = x$, and

w = weight of a cubic foot of earth.

$$W = \frac{w}{2}\,\tan.\,\alpha$$
$$\therefore P = \frac{w}{2}\,x^2 \tan.\,\alpha \cot.\,(\alpha + \phi) \ldots\ldots\ \ldots\ldots\ (1)$$

It is evident from the above expressions that, as α increases, the mass of earth to be supported increases, but the inclination X Y decreases; these effects tending to counteract each other, we must therefore, to find the greatest value of P, determine the inclination with respect to which their neutralizing influence is least.

The maximum value of P will be attained when,

$$\frac{d\,P}{d\,\alpha} = o, \text{ and } \frac{d^2\,P}{d\,\alpha^2} < o$$

But differentiating equation (1) in respect to α, and reducing we obtain,

$$\frac{d\,P}{d\,\alpha} = \frac{w}{4}\,x^2\,\frac{\sin.\,2\,(\alpha + \phi) - 2\sin.\,2\,\alpha}{\cos.^2\,\alpha\,\sin.^2\,(\alpha + \phi} \quad (2)$$

Let the numerator and denominator of the fraction in the second part of this equation be equal to p and q respectively,

$$\therefore \frac{d^2\,p}{d\,\alpha^2} = \frac{w}{4}\,x^2\,\frac{1}{q^2}\left(\frac{d\,p}{d\,\alpha}\,q - \frac{d\,q}{d\,\alpha}\,p\right)$$

but when

$$\frac{d\,P}{d\,\alpha} = o\,p = o$$
$$\therefore \frac{d^2\,P}{d\,\alpha^2} = \frac{w}{4}\,x^2\,\frac{1}{q}\,\frac{d\,p}{d\,\alpha}$$

whence it follows that for every value of α, by which the first condition of a maximum is satisfied, the second differential co-efficient becomes,

$$\frac{d^2\,P}{d\,\alpha^2} = \frac{w}{2}\,x2\,\frac{\cos.\,2\,(\alpha + \phi) - \cos.\,2\,d}{\cos.^2\,\alpha\,\sin.^2\,(\alpha + \phi} \quad (3)$$

Now it is evident from equation (2) that the condition $\frac{d\,P}{d\,\alpha} = o$ is satisfied when,

$$2\,(\alpha + \phi) = \pi - 2\,d$$

or

$$\alpha = \frac{\pi}{4} \quad \frac{\phi}{2}$$

substituting this in equation (3)

$$\frac{d^2\,P}{d\,\alpha} = w\,x^2\,\frac{-\sin.\,\phi}{\cos.^2\left(\frac{\pi}{4} - \frac{\phi}{2}\right)\sin.^2\left(\frac{\pi}{4} + \frac{\phi}{2}\right)}$$

which expression is essentially negative, so that the second condition is satisfied by this value of α. It is that, therefore, which corresponds to the maximum value of P; and substituting in equation (1), and reducing we obtain

$$P = \frac{w}{2}\,\tan.^2\left(\frac{\pi}{4} - \frac{\phi}{2}\right)$$

which represents the actual pressure of the earth on a wall whose width is one foot, and depth x.

REVETMENT WALLS.

If, instead of a revetment wall sustaining the pressure of a mass of earth, the weight of a cubic foot of which is represented by w, it had sustained the pressure of a fluid, the weight of a cubic foot of which was represented by

$$w \tan.^2\left(\frac{\pi}{4} - \frac{\phi}{2}\right)$$

then would the pressure of that fluid have been represented by

$$\frac{w}{2} x^2 \tan.^2\left(\frac{\pi}{4} - \frac{\phi}{2}\right)$$

so that the pressure of a mass of earth upon a revetment wall, when its surface is horizontal, is identical with that of an imaginary fluid, a cubic foot of which has a weight, w^2

$$= w \tan.^2\left(\frac{\pi}{4} - \frac{\phi}{2}\right)$$

By substituting this expression in the formulæ for retaining walls, the conditions necessary to stability may be found.

ON THE CONSTRUCTION OF IRON ROOFS.

By J. J. Birckel.

(*Illustrated by Plates No.* 222 *and No.* 223.)

(*Continued from page* 202.)

Example, Fig. 1 and details illustrate a roof designed and made by Mr. Rankin, of Liverpool, for the Hon. C. Napier's Paper Mill at Dartford. The rafters are trussed on the principle of diagram No. 3, with only one secondary truss; they are made of ⊤ iron, 3 in. × $2\frac{1}{2}$ in. × $\frac{3}{8}$ in., and bear a stress of about $5\frac{1}{2}$ tons on the square inch; the ties and braces are all made of flat bars, and the pull on the square inch is, for the lower ties, 6 tons, and for the braces $4\frac{3}{4}$ tons, deduction being made for bolt holes. Ventilation is obtained by means of a lantern roof, the standards of which are provided with louvre blades of rolled iron, No. 20 W. G., and are placed at a suitable angle not to allow the rain to enter; skylights of about 5 feet in width extend over the whole length of the roof on both slopes, the glass resting upon ⊤ iron sash bars, 2 in. × $1\frac{3}{4}$ in. × $\frac{1}{4}$ in., placed about 12 inches apart, which themselves are supported by angle iron purlins of adequate strength. The lower portions, as well as the lantern roof, are covered with slate, which rests upon angle iron laths, $1\frac{1}{4}$ in. × $1\frac{1}{4}$ in. × $\frac{1}{8}$ in., placed at distances of 10 inches apart, and though very light are of ample strength, the principals being only 6 feet apart. A detail sketch shows the method of fixing the slates, which is done almost as readily as in the examples already commented upon, without the use of boarding, and is not nearly so heavy; nor is it more expensive, for upon careful calculation we find that the cost of the iron purlins per square foot of roofing is $2\frac{1}{4}d.$, and the cost of the square foot of $1\frac{1}{4}$ in. boarding, is just the same, if the timber be taken at the moderate price of 1*s.* 9*d.* per cube foot. On the whole, therefore, this is a neatly-designed roof, and is well proportioned in its chief parts; as there is no particle of wood in the whole structure, its chances of destruction by fire are very small, for it would require a very hot furnace upon the floor of the building—about 20 feet below the roof—to have any appreciable effect upon the latter.

Example, Fig. 4 and detailed figures illustrate one of the roofs of the Battersea Locomotive Works, now in course of erection, and was designed we believe, by Mr. Cubitt. The rafters are made of two angle irons, 4 in. × $2\frac{1}{2}$ in. × $\frac{1}{2}$ in., bolted together back to back, with a wood packing between them, for convenience of fastening the boarding, which carries the slates. The thrust upon the rafters, if the load be again assumed at 40lbs. per square foot, is 22 tons, and, taking into account the bending *moment*, the whole stress upon the square inch is about 10 tons; the tie rod, made of round iron, with suitable bosses forged at the joints, with the vertical ties, has to sustain a maximum pull of $20\frac{3}{4}$ tons, and, the area being 3·14 square inches, sustains a stress of $6\frac{3}{4}$ tons on the square inch. The king post, made of $1\frac{1}{4}$ in. round iron, sustains a stress of 5 tons on the square inch; its junction with the main tie rods, and with the struts of the upper secondary trusses, is made by means of two strong plates, to which the whole of them are bolted, and is one of the neatest arrangements we have yet seen. The struts connecting the king and queen posts are made of ⊤ iron, $2\frac{1}{2}$ in. × 2 in. × $\frac{1}{4}$ in., and sustain a thrust of 4 tons on the square inch; the other struts and vertical ties are proportioned in a similar manner. As the principals are 14 feet apart, there was a necessity for strong purlins, which have been made of two channel irons, 4 in. × $1\frac{1}{2}$ in. × $\frac{1}{4}$ in., bolted together back to back, with a wood packing between them; and the greatest stress upon them will be about 6 tons to the square inch. On the whole, therefore, this roof is very well proportioned, and as it is very neat in the details of its construction, it may with good reason be held forth in all these respects as an example to be imitated. There is one point, however, in its construction which is open to very grave objections, namely, the introduction of the wood packing and planking for convenience of fastening the slates. The weight of iron contained in principal and purlin forming one bay of the roof, is about 32 cwt., and the weight of wood in the same space is about 33 cwt., both materials being, practically speaking, in equal weight. Now, 33 cwt. of wood can develope a quantity of heat equal to that developed by about 16 cwt. of coke, and these, at the ordinary rate of consumption in a cupola, could melt down at least 120 cwt. of pig iron. Should this roof, therefore, by any mischance take fire, if not discovered in time, nothing could save it from utter ruin. It is, of course, not contended that the whole of the iron would be melted down, but the great proportion of wood in contiguity with the iron can leave no doubt upon the minds of our readers that, even should the roof not come down with a crash, the whole must be so much injured as to be quite unsafe, and unfit for further use. How anyone can deceive himself into the belief that he has made a fire-proof building, when he has covered it with a roof like this, is to us a matter of great mystery. But, if the roof is not to be fire-proof, why, we ask, make all its vital parts of iron, or why introduce any iron at all, when it is universally admitted that wooden structures of this kind, notwithstanding the great progress in the manufacture of iron, still remain much cheaper than iron ones? The roof, however, was meant to be fire proof, and the wood, which in reality forms no part of it, is a matter of secondary consideration only; it is a dead weight which only keeps the slate in its place; its destructive power has not been taken into consideration, and as we shall have occasion presently to show that it can be very well dispensed with, we may safely say that its presence here is a decided mistake.

Example, Fig. 12 with details, Figs. 13 to 15, illustrate the roof of a shed at Chatham Dockyard, and was designed by the engineers of the Admiralty; it is covered with corrugated iron, and, in consequence, has a very small rise, the angle being 1 in $4\frac{1}{4}$. With a load of 40lbs. per square foot, we should have $\frac{1}{4}$ W = 4 tons, and the maximum stress on the rafter would be $22\frac{1}{2}$ tons, to resist which we have a ⊤ iron 5 in. × 5 in. × $\frac{1}{2}$ in. equal to 5 square inches in section, and causing a stress of $4\frac{1}{2}$ tons to the square inch; this, however, does not take into account the bending stress, although it so happens that at the foot where the thrust is greatest, the purlin sits very nearly at mid distance between two consecutive centres of support. Further up, the purlins sit very nearly upon the centres of support, and as the assumed load of 40lbs. is considerably greater than it ever will be, there is no doubt that the rafter will be quite strong enough; the maximum pull on the tie rod would be 19 tons, and has an area of $3\frac{1}{4}$ square inches, deduction being made for bolt holes, thus occasioning a stress of about $5\frac{3}{4}$ tons on the square inch. The pull on the king post is about $7\frac{1}{2}$ tons, its area $1\frac{1}{2}$ square inches, and the stress upon the square inch about 3 tons. So far, therefore, this roof is very fairly proportioned; but, upon examination of the secondary trusses, we find that the strengths of both struts and vertical ties are out of all reasonable proportion: the pull on the queen rod, for instance, is $2\frac{1}{4}$ tons, its area $2\frac{1}{6}$ square inches, and the stress upon the square inch $1\frac{1}{17}$ tons, while the thrust upon the strut connecting the queen and queen rods is $3\frac{1}{2}$ tons, with an area of 4 square inches, the stress on the square inch being $\frac{7}{8}$ tons. The succeeding struts and ties are similarly proportioned, and the whole of them might have been reduced by the amount of one-half their strength at least. We must also remark that the vertical tie, connecting the upper centre of resistance of the lower truss with the main tie rod, is perfectly useless, as it gives no additional rigidity to the trussing. The tie rods, it will be noticed, are made of flat iron of uniform width and thickness, and are a little heavier than they would be if they had been made of uniform area; but as this arrangement avoids all expense of smithing, the final cost is found to be less, in spite of the additional weight of metal. The struts of the secondary trusses are jointed to the rafters by means of two straps, as shown in the detail sketch, and are dipped at their lower ends between the main tie rod, which is double, for convenience of making the joints. The corrugated iron covering is carried by means of ⊤ iron purlins 5 in. × 4 in. × $\frac{1}{2}$ in., which are stronger than they are really needed, the principals being only 9 feet apart. The shed is lighted from above, by means of two skylights, the glass being carried by ⊤ iron sash bars, 2 in. × $1\frac{1}{2}$ in. × $\frac{5}{16}$ in, placed about 12 in. apart, and provision is made for ventilation by means of a louvre roof, raised sufficiently to allow of the free circulation of air. Before concluding our observations on this example, and although we do not intend to enter into the discussion of the stability of the supports of roofs, we must call attention to the very peculiar case of the pillars supporting the one under consideration. Professor E. Hodgkinson has positively proved by his experiments that pillars with flat bases, of ample area, offer three times the resistance of pillars rounded at the base, the height and transverse section being the same; yet, and notwithstanding this well known fact, have these been almost tapered down to a point!—for what rational purpose we are at a loss to find out.

After careful examination of the examples submitted, we are enabled to draw the inference that in roofs chiefly made of iron, there results no material saving from the introduction of wood for the convenience of merely fastening the covering. And where there are no special causes for the use of wood, as, for instance, a desire or necessity of preserving, as far as possible, an even temperature inside the building, we would strongly deprecate the use of wood, as being an inherent source of danger to the structure of which it forms part. The great calamities which have occurred during the last twelve months are in themselves alone sufficient to justify us in raising a warning voice against the use of a material so suicidal—yet, it is true, so easy and so universal in its adaptation.

CIRCULAR ROOFS.

From reasons of taste,—and in the case of roofs of very large spans, most probably from reasons of economy, engineers are sometimes induced to construct roofs in the shape of an arch whose outlines are fixed generally as much by the laws of æsthetics as by those of statics. In such roofs the principal assumes pretty much the character of a linear arch, stiffened by means of a system of trussing, as in the case of a triangular roof; but as the principles of stability of the arch itself have, until within a comparatively recent period, been but imperfectly understood by scientific men, and still remain a matter of great mystery, at the present period, to the greater part of that very respectable body of men called practical engineers, so in proportion to the want of a proper knowledge of this subject, have these gentlemen gone astray from truth in their designs of arched roofs.

One of the earliest structures, nay, we believe the first structure of this description built since the introduction of iron into the architecture of roofs, and which (notwithstanding the inaccuracy of its design as a trussed frame to be pointed out presently) has gained a very great celebrity—is (figures 5 to 8), the roof over the Lime Street Railway Station at Liverpool—and as it has withstood the destructive action of a lapse of time of some thirteen years, it may reasonably be affirmed, also, that it is deserving of that celebrity. The fact, however, of any structure resisting the action of time, and accomplishing the objects for which it was called into existence, is no proof of its being a correct embodiment of scientific truths, but simply proves that so far the structure has proved strong enough; neither should this fact exempt it from a critical analysis, the result of which might prove very useful in future practice.

This roof is described by its designer, Mr. Turner, "as consisting of a series of segmental principals or girders, fixed at intervals of 21ft. 6in. from centre to centre, trussed vertically by means of radiating struts made to act upon the rafters by straining the tie rods and the diagonal braces. Each principal or girder is composed of a wrought-iron deck beam 9in. in depth, with a plate 10in. wide and $\frac{1}{4}$in. thick, rivetted on the top; the upper flange of the deck beam is $4\frac{1}{2}$in. wide and $\frac{1}{2}$in. thick; the lower flange is 3in. wide and 1in. thick. The beam is strengthened at the haunches for a distance of 27ft. from the springing, by plates 7in. broad, and $\frac{5}{8}$ of an inch thick, fastened together by rivets."

Here, therefore, the principal is distinctly described as an arched lattice girder, whose compression and tension flanges are connected by means of a succession of radial struts, and of ties sloping from the centre towards the walls or supports; and it will be seen by reference to Fig. 5, that the depth of the girder diminishes from the centre in the direction of the supports, until the compression and tension flanges meet at each of the extremities. But for this latter feature in its construction, it would be like an ordinary lattice girder, with vertical struts and ties sloping from the bottom of one strut to the top of the following one, in the direction of the supports; the fact of the two flanges meeting, however, alters the case materially, inasmuch as it compels the last sloping rod or tie, as Mr. Turner would have it, to fall upon the compression flange itself for its support; and when we remember that the strains upon those ties accumulate from the centre of the girder, where they are smallest, towards the ends where they reach their maximum, if we construct the diagrams of stresses on this hypothesis, as illustrated by Fig. 12, Plate 223, and on the assumed load of 40lbs. per square foot, we find that the last sloping rod, if it acts as a tie, exerts a component transverse strain upon the rafter or compression flange, equal to about 35 tons, at a distance of 11ft. from the wall or column. As the actual direction of that supposed pull is from the wall or columns, and as the principal rests only loosely upon them, we do not see on what principle of dynamics or of statics it is not pulled away from its supports and precipitated into the area below; for hitherto we have been taught, and we have believed, that wherever there is a pressure not balanced, there must be motion in the direction of that pressure; and in the case under consideration, if there is a pull upon the said sloping rod, it cannot be neutralised by the reaction of the wall, for the rafter is the only medium which could connect it with the wall. It is not supposed to be neutralised by the tension flange or tie rod, for this could only be effected by a compression strain on the tie rod; and to suppose this would be looked upon by the designer of the roof himself as an absurdity. The only resistance that we can perceive is that offered by the rafter and the tie rod to bending and doubling up in the centre, a resistance which, considering their dimensions, would be of little avail against a component horizontal pull of some 160 tons, with a leverage of 20ft.; this supposed pull, therefore, could only bring about a dynamical equilibrium, the effect of which must be to bring down the roof.

We think, however, that it will not be difficult to prove that those supposed sloping ties do not act as ties at all, but act as struts; and that the supposed radiating struts act as ties. To this effect we will, for an instant, suppose the principal to be without any weight of its own, and free from all external load; in fact, we will suppose it to be a linear structure capable of resisting any pressure we may choose to apply. At the points C_1 we will now apply certain pressures, which, to simplify the case, we will suppose to be normal to the curve of the rafter, and of equal intensity on both sides. It is evident that these pressures will produce compression on the portions A C_1 of the rafter, and on the sloping rods A_1 C_1, which compression strains are balanced by a tension strain on the parts A A_1 of the tie rod; the radial components of the strains on A_1 C_1, by means of the roots A_1 C_2 are carried to the points C_2, where they produce results similar to those produced by the pressures at C_1, namely, compression on the portions A C_2 of the rafter, and on the rods C_2 A_2, which are again balanced by a tension strain on the portions A A_2 of the tie rod, and the same fact reproduces itself upon the successive trusses until the summit of the roof is reached, the several strains accumulating progressively upon the rafter and the tie rod as we approach the extremities of the principal. If now we apply certain pressures at each of the centres of resistance C_2, C_3, C_4, these respectively will add themselves to the pressures transmitted from each preceding centre of resistance to the radial rods by means of the sloping rods, and the system of trussing thus naturally reduces itself into a series of radial or *quasi* vertical ties connected by means of sloping struts, or king and queen post system of trussing.

To the analysis which has led us to the above conclusion, and to the objection which, no doubt, will be raised by the more superficial inquirer, that if the ties of the Lime Street roof are struts in reality, the roof could not have stood the test of time, we shall give the ready answer, that the fact of the roof having stood this test only proves that, up to the present time, those struts have been able to do their work of resistance, and that the rafter itself, being a strong beam, required little trussing to enable it to do its work. Indeed, if we construct the diagram of stresses, as illustrated by Fig. 13, Plate 223, on the hypothesis of the principal being a polygonal frame trussed on the system of the king post roof, with an assumed of 40lbs. per foot, we find that the stress upon the rafter is a little less than 4 tons per square inch at the foot, and about 8 tons in the centre of the bay C_3 C_4; the maximum stress on the sloping struts is $6\frac{1}{2}$ tons, and that on the main tie rods about $9\frac{1}{2}$ tons per square inch, which figures are a clear proof of the correctness of the remarks we have just made. This roof, therefore, if modified in the manner we have suggested, will at all times be an elegant example to imitate; and though we have referred to it as a theoretical blunder (a blunder which will be readily excused when it is remembered that at the time of its construction the theory of structures had not yet been rendered so easily accessible as it is now, with the help of such works as those of Rankine and Moseley), yet it is an example of iron roof construction well worthy of recording, because it represents a great stride in advance of what had previously been effected in roof construction, and must be looked upon as a bold and practically successful conception of the mind of man.

No sooner had the Lime Street roof been fairly tested, than engineers at once entertained the possibility of still greater achievements, and in the year 1853, Messrs. Fox and Henderson constructed the roof over the New Street station at Birmingham, with a maximum span of 212ft., being 60ft. larger than that of the Lime Street roof, and we believe, up to this time, the largest span known. In its general features, the design of the principal of this roof, which we have illustrated in Plate 223 at Fig. 1, and accompanying details, resembles much the one previously commented upon. The rafter consists of a plate beam 15in. deep, with top and bottom flanges of ⌊ iron 6in. × 3in. × $\frac{1}{2}$in. thick, and midweb $\frac{11}{16}$ thick; the main tie rod is round, 4in. diameter throughout, and with the only difference of the so called struts being vertical instead of being radial, and of its having crossed diagonals instead of single ones, it may be said to be a copy of the former. Our arguments, therefore, put forward in discussing the nature and merits of the trussing in the Lime Street roof, would apply here again, and would lead us to the same conclusion, namely, that the reactions take place as in the case of the king post system of trussing, and that the principal should have been constructed according to this system.

In some of its details it differs greatly, and we think unfavourably, with the former; the succeeding lengths of the tie rod, for instance, are connected by being screwed into a wrought iron coupling box, a method very expensive in the first stage of preparing the work, and very troublesome in the subsequent stage of putting it together; the so called vertical struts are made of four light ⌊ irons, distanced by means of cast crosses in such manner as to be farther asunder in midlength of the strut than at the ends, and assembled by means of bolts passing through those crosses, the whole, it must be perceived, requiring much labour, and on that account being very expensive. The sloping struts having been supposed to act as ties, are comparatively weak, but as there are two diagonals in each bay, rivetted together at the points where they cross, this defect is greatly lessened, because the length of the actual strut, owing to this circumstance, is greatly reduced.

The design of the roof having been made upon an erroneous assumption, we shall not enter into an analysis of the strengths of the several parts of the principals, but shall simply state that, had its designer started from a correct hypothesis, it would, most undoubtedly, have been considerably lighter.

We must notice also that the purlins are made of wood trussed with iron, a fact which we cannot consider an improvement upon the Lime Street roof, either on the score of security or on that of elegance. We have, however, thought proper to introduce it to our readers, because a structure which has the merit of being the largest of its kind in existence must, at all times, be a subject of much interest to all professional inquirers.

Mr. Fairbairn, who was one of the parties consulted about the practicability of Mr. Turner's design, and whose opinion at the time was in favour of it, seems to have given the subject upon which we are engaged his early attention, and, with his habitual sagacity, seems to have arrived at a correct comprehension of it; for, in 1857, he caused the boiler-yard, now belonging to Messrs. Fairbairn and Co., to be covered in with an arched roof (illustrated in Plate 223, Fig. 5, and accompanying details), consisting of two spans of 50ft., with principal trussed on the system according to which, in the roofs previously analysed, we have demonstrated the reactions describeb to take place. We would not, however, have our readers believe that this is the only way to truss an arched principal correctly, for it might be trussed, with theoretical propriety, according to the system illustrated by Figs. 1 and 2 of our first paper on roofs; but we think that the king post system has a claim to preference, because, on the one hand, it seems to us the more elegant of the two, and because, also, the thrust on the upper portion of the rafter, as we have seen, is considerably less with this system than with the other, a circumstance which here is of much importance, because the almost horizontal position of that portion of the rafter causes the bending stress to be considerably larger for the same vertical load than it is at the foot of the rafter.

If, now, we construct the diagram of stresses, Fig. 11, with a due regard to this particular feature of the problem that the stress upon any portion of the polygon is represented, both in the primary and in the secondary trusses, by a line drawn parallel to that portion of the polygon, from the point of intersection of the extreme lines closing the diagram of the particular truss of which that portion of the polygon forms part, we find that the rafter which is made of ⊤ iron $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$, sustains a stress of about 6 tons on the square inch, and is so small because the purlins have been placed so close to the several centres of resistance as to render the bending stress almost nil; the tie rod is made of $1\frac{1}{4}$in. round iron, and sustains a pull of $5\frac{1}{3}$ tons per square inch; the stress on the struts, also, of the upper and lower secondary trusses is about one ton per square inch; the struts are made of ⊤ iron, respectively $3\frac{1}{2} \times 3 \times \frac{5}{16}$ and $2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$ in section. The roof is covered with corrugated iron; the principals, which are 11ft. apart, are carried by strong wrought iron beams, which themselves rest upon the end walls of the building, and between those on two strong cast-iron columns 18in. diameter, thus causing as little obstruction as possible on the floor below; the shop receives the light from a louvre roof, glazed in the whole of its width of about 16ft., and by means of which ample provision is made also for ventilation. On the whole, therefore, this roof is very well proportioned, and in its place it looks exceedingly elegant.

THE PROPOSED NEW PATENT OFFICE.

The following is the recent report of the Commissioners of Patents to the Lords Commissioners of the Treasury on the subject of building a Patent Office, Library, and Museum:—

"In April, 1855, Lord Chelmsford, Lord High Chancellor of Great Britain, Sir John Romilly, Master of the Rolls, Sir Fitzroy Kelly, Attorney-General, and Sir Hugh M'Calmont Cairns, Solicitor-General, being four of the Commissioners of Patents for Invention under the said Act, reported to your lordships in the words following:—

"The 4th sec. of the Patent Law Amendment Act, 1852, enacts that 'it shall be lawful for the Commissioners of her Majesty's Treasury to provide and appoint from time to time proper places or buildings for an office or offices for the purposes of the said Act.'

"In pursuance of the requisition of the Lords Commissioners of her Majesty's Treasury, dated in 1853, the Commissioners of her Majesty's Board of Works provided certain offices for the Commissioners of Patents, being the ground-floor rooms of the Master's Offices in Southampton-buildings, Chancery-lane, thereto occupied by Masters in Chancery, abolished under the Act 15 and 16 Vic., c. 80; and an annual rent of £490 is now paid out of the Fee Fund of the Patent Office to the Suitors' Fund of the Court of Chancery for the hire of the same.

"This arrangement was not considered to be permanent; no lease has been granted, and as these offices are now required for the occupation of the registrars and other officers of the Court of Chancery, due notice has been given to the Commissioners of Patents, requiring them to give up possession as soon as other suitable offices can be procured.

"These offices were in 1853 sufficient in number and accommodation for the ordinary business of the office.

"In the year 1855 the Commissioners of Patents established a free public library within their office, containing works of science in all languages, the publications made by the commissioners, and the works upon patented and other inventions published in the British colonies and in foreign countries.

"This library has greatly increased and continues to increase, partly by purchases, but in a great measure by gifts of valuable and useful books. It was resorted to at the first opening by inventors, engineers, and mechanics, as well as by barristers, solicitors, and agents engaged in patent business; it has become a collection of great interest and importance, and the number of readers has so much increased that at this time convenient standing room cannot be found in the two small rooms within the office which can be appropriated to the library. It is the only library within the United Kingdom in which the public have access not only to the records of the patents and inventions of this country, but also to official and other documents relating to inventions of this country, but also to official and other documents relating to inventions in foreign countries, and this without payment of any fee.

"A largely increased accommodation is urgently required.

"No suitable building can be found in the immediate neighbbourhood of Southampton-buildings, either to be rented or for purchase.

"The new offices to be provided must be fire-proof, for the preservation of the original specifications and other records of the office; the offices now occupied are fire-proof throughout.

"The Commissioners of Patents are in possession of a collection of very valuable and interesting models of patented machines and implements, as also of portraits of inventors, many of them gifts, and others lent by the owners for exhibition. They are now exhibited daily, and gratuitously, in a small portion of the museum at Kensington assigned to the Commissioners of Patents for that purpose by the Lords of the Committee of Privy Council for Trade.

"A museum of this nature naturally increases, and the number of models now exhibited may be considered as forming only the foundation of a great national museum.

"The great work of printing the old specifications of patents, with the drawings attached thereto, enrolled in Chancery under the old law, dating from 1823 to 1852, and 12,997 in number, was commenced in 1853 and completed in 1858. All have been fully indexed in series and subjects, and the indexes printed and published. These prints of specifications form about 900 volumes (450 imperial octavo volumes of drawings, and the like number of imperial octavo volumes of letter-press.) The indexes form seven imperial octavo volumes. These valuable works have cost, in transcribing, printing, lithographic drawing, and paper, upwards of £90,000.

"Notwithstanding this great outlay, the balance sheet of income and expenditure for the year 1857, prepared for the annual report of the commissioners, and laid before Parliament, shows a surplus income from the commencement of the Act, 1st October, 1852, to the end of 1857, of £6000.

"The balance sheet of income and expenditure for the year 1858, will, no doubt, increase the total surplus to £12,000 or £13,000.

"The work of printing the old specifications being completed, as above stated, the expenditure on that head ceases altogether, and consequently, the surplus income of the year 1859, is estimated at £31,000; adding this sum to the available surplus of £12,000, as above stated, and allowing a margin of £3,000, £40,000 may be safely estimated as the sum available for building purposes at the end of the year 1859.

"The Act of 1853 (16 Vict., c. 5), converted all the fees imposed by the Act of 1852 into stamp duties, thereby passing the whole income of the office to the Consolidated Fund. The expenditure of the office is estimated and voted annually by Parliament.

"There is no appearance of diminution in the number of applications for patents, and they may be safely estimated to continue for future years at £3000 in each year.*

"This number will produce £95,000 in stamp duties, and adding thereto £1600 for the average annual proceeds of sales of printed specifications, the future annual gross income may be taken at £96,000. The gross income is, however, liable to a deduction of £18,500 on account of revenue

* The number of applications in 1861 was 3276.

stamp duties, leaving the real available future income of the Patent Office at £78,100* per annum, or thereabouts.

"The Patent Law Amendment Act, 1852 (15 and 16 Vict. c. 83) imposed certain revenue stamp duties upon patents. These duties have hitherto produced £15,300 per annum, and that sum has been charged against the office in the annual balance sheet of income and expenditure. These duties are estimated for future years to produce £18,500† or thereabouts.

"The work of printing the old specifications being completed, as above stated, the yearly future cost of the current specifications, abstracts of specifications, journals, indexes, &c., in letter-press printing, lithographic printing, and paper, will not exceed £17,500‡ per annum, as contrasted with the average yearly expenditure on those three heads of £36,375 within the years 1856-7-8.

"The Commissioners of Patents are of opinion that it is not expedient to propose to Parliament a reduction of the scale of stamp duty fees imposed by the Act of 1852.

"They are of opinion that the fees paid upon the passing of a patent are not too heavy; the large number of applications (3000 in each year), accounting for the large amount of income. Any material reduction in the amount of fees would undoubtedly tend to increase the number of useless and speculative patents; in many instances taken merely for advertising purposes.

"The fee stamp duties and the revenue stamp duties are as follows:—

	Fee Stamp Duties. £	s.	d.	Revenue Stamp Duties. £	s.	d.
Within the first six months from the petition for provisional protection to the filing of the specification	20	0	0	5	0	0
On the patent at the expiration of the third year ...	40	0	0	10	0	0
On the patent at the expiration of the seventh year...	80	0	0	20	0	0
(The patent is granted for fourteen years.)						

"There are 3000 petitions for provisional protection presented in each year or thereabouts. Of this number 1950 reach the patents, and 250 patents pay the £50 additional stamp duty required at the expiration of the third year; 1450 patents, or nearly three-fourths of the whole thereby becoming void. Probably not more than 100 of the surviving 550 will pay the £100 additional stamp duty required at the end of the seventh year.

"Considering the beneficial results of the additional payment of £50 in sifting useless patents, the commissioners are of opinion that it is not expedient to reduce the amount, and so long as the surplus can be expended for the benefit of patentees and that portion of the community which is principally interested in and connected with the practical application to public purposes of discoveries and improvements in science and art.

"They are of opinion that the surplus income, calculated as before stated, to amount to £30,000 at the end of the current year 1859, and to increase in each succeeding year at the rate of £20,000 per annum, may be beneficially applied in the purchase of ground in a central situation, and in the erection thereon of a sufficiently spacious fire-proof building for the Patent Office and public free library attached thereto; and that the surplus fund may be beneficially applied in the purchase of ground and the erection thereon of a permanent and spacious building for the Patent Office Museum, sufficient ground being taken for the extension of the building, from time to time, as may be required.

"This is the more necessary, inasmuch as models of a most interesting and valuable description lie scattered over the kingdom, in many instances constructed at a great expense, for legal and other purposes, for which the owners have no present use, and many of which occupy a space inconvenient to them. These models, or many of them, would, as the commissioners confidently expect and believe, be presented or entrusted to them for exhibition in such museum, provided the public are allowed free access to it at all reasonable times.

"The Commissioners of Patents therefore request that the Lords Commissioners of Her Majesty's Treasury will be pleased to sanction the application of a certain portion of the surplus now derived from the fees paid on patents for the purpose of accomplishing the objects above mentioned, and that with this view their lordships will be pleased to give the necessary directions to Her Majesty's Board of Works, to obtain a proper site for the proposed new Patent Office and Library, to be selected with the approbation of the Commissioners of Patents and with the sanction of the Lords Commissioners of Her Majesty's Treasury, and also to prepare the necessary plans, elevations, and specifications for this purpose, also to be submitted to the Commissioners of Patents for their approval, and to make contracts for the building of the same when approved.

"If their lordships consent to these proposals, the Commissioners of Patents have to request that a sufficient sum for the purpose, so far as the same may be required for the year 1858-9, may be included in the estimate to be laid before Parliament in the present cession for Patent Office expenses.

"This report was, immediately on the receipt thereof by their lordships, transmitted by them to Her Majesty's Board of Works, with instructions that a convenient site should be provided for the proposed new offices, public library, and museum, and also that plans and estimates should be prepared for Parliament.

"In 1859 the Lords Commissioners of Her Majesty's Treasury and the Chief Commissioners of Her Majesty's Board of Works approved of a site for this purpose, lying at the northern extremity of the gardens of Burlington House, and thereupon plans and estimates were prepared for the new Patent Office and library, by Messrs. Banks and Barry, the architects appointed by the Board of Works, which were so arranged as to form a portion of one complete design for the appropriation of the whole site of Burlington House and gardens for various public buildings. This plan was, however, suspended or altogether abandoned on the change of government in that year (1859), and no other site has since been provided.

"The space required for these buildings may be estimated from the following circumstances:—It is considered by the Commissioners of Patents to be highly desirable, and indeed necessary, that the Patent Office Museum should be so constituted as to become an historical and educational institution for the benefit and instruction of the skilled workmen employed in the various factories of the kingdom. These persons constitute a class which largely contributes to the surplus fund of the Patent Office in fees paid upon patents granted for their inventions. Amongst the various things necessary to be done in order to accomplish this object, it is considered to be of great importance that machines and exact models of machines, in subjects and series of subjects, showing the progressive steps of improvement in each branch of manufacture, should be exhibited. For example, taking the case of steamboats, in order to show the rise and progress of this invention, it is necessary to exhibit in a series of exact models of machines, or by the machines themselves, each successive invention and improvement in steam propellers, from the first engine on the paddle system that drove a boat of two tons burthen to the powerful machinery of the present day on the screw system in first-rate ships of war. Accordingly the present museum presents a very interesting collection to elucidate this subject. The original small experimental engine engine that drove the boat of two tons burthen above referred to, is now in the museum and stands the first in the series of propellers and models of propellers; and in order to explain how the existence of such a museum is the cause of its becoming daily more perfect, it may be useful to state that in this branch the following valuable and interesting original machines and models of machines have lately been added to the museum, either by the gift of the proprietors or at a very trifling expense:—

"First, a perfect model of Trevethick's locomotive engine, the first engine that ran upon common roads, in 1803.

"Secondly, an original stationary and pumping engine, made on Newcomen's principle, to which Watt applied his important invention for condensing, by the means of a separate vessel and air pump, the steam that had been used and formerly condensed in the cylinder.

"Thirdly, the orginal fixed engine made by Watt in 1788 for converting rectilinear into circular motion, in order thereby to drive mill work by the use of his invention known as the sun and planet motion. These two last-mentioned engines drove for many years the machinery used at the Soho Works of Messrs. Bolton and Watt, near Birmingham.

"Fourthly, the very early original locomotive engine, brought from the Wylam Colliery, in Durham, the first engine which moved by the contact of smooth wheels on smooth rails. This engine was worked at the colliery nearly fifty years, commencing in 1813.

"And fifthly, the original "Rocket" locomotive engine made by George Stephenson and worked at the opening of the Liverpool and Manchester Railroad in 1829, which unfortunately was the cause of Huskisson's death.

"These instances are selected from one division of the museum, and are enumerated for the purpose of pointing out, in the first place, the value of such a museum in an historical and social as well as in a scientific point of view, and in the second place, the large space that must necessarily be required for the purpose of their accommodation, in such a manner as to enable those who wish to study them to be able to do so without difficulty or inconvenience. It is also to be borne in mind that the number of the models and machines will increase rapidly, year by year, and consequently

* The available income of the Patent Office amounted in 1860 to £92,000.

† The revenue stamp duties produced £18,485 in 1861.

‡ The cost of printing, lithographic drawings, paper, books, and binding, for the year 1861, amounted to £18,800.

that a large additional space of ground should be secured for the future extension of the museum.

"The commissioners are also in possession of a large number of valuable models, which still remain in cases, because room cannot be found for their exhibition in the space assigned to them in the museum at South Kensington; indeed, so limited is that space, that they are obliged to postpone the acceptance of many valuable models offered as gifts by manufacturers and inventors. Several good models of machines have also, for the same reason, been lately removed to afford room for machines of a higher degree of interest.

"The public library at the Patent Office is in the same crowded condition; the books daily increase in number, and many remain in cases, for the reason that shelf-room cannot be found for the books, and still less accommodation for the readers.

"The inconvenience arising from this source is accurately pointed out in a memorial, presented to the Commissioners of Patents on the 22d of July last, and signed by forty-six gentlemen, consisting of eminent mechanical engineers, chemists, manufacturers, inventors, and agents, who are readers in the public library of the Patent Office. A copy of the memorial, so far as it relates to this subject, is appended to this report.

"In connection with the erection of the necessary buildings for the objects above specified, a most important consideration is the spot to be selected for that purpose. The readers in the library being of the class of scientific persons, barristers, mechanical engineers, chemists, inventors, skilled workmen in the various factories, solicitors, and patent agents, it is obvious that the readers should be enabled to read the books and examine the machines and models at the same time and in the same place, and, consequently, that the Patent Office, Public Library, and Museum, should be either under the same roof or in very close proximity, and also that the spot to be selected should be of easy access to the class of persons above referred to.

"The proposed site for the Patent Office Buildings in Burlington House-gardens having been abandoned, as above stated, the Commissioners of Patents, in the following year (1860), proposed to your lordships, Fife House, in Whitehall, as a convenient site for the Patent Office Buildings and Museum, and one that would unite all the necessary requirements already referred to. This proposal was favourably considered, and a minute of the Treasury was transmitted thereon to the Board of Works. It was found, however, that until the question of the embankment of the river and the roads of access to the main river-side road should have been settled by Parliament, no appropriation of that site for building purposes could be made.

"This difficulty is now removed. The several roads have been set out and definitely fixed by the Thames Embankment Act of the present session, and it is consequently now open to her Majesty's Government, if it shall think fit to do so, forthwith to appropriate the site of Fife House for the erection of the proposed Patent Office buildings.

"The Crown leases of Fife House and the several buildings adjoining thereto have lately expired, and therefore the whole property is now at the disposal of her Majesty's Commissioners of Woods and Forests in right of the Crown; and the Commissioners of Patents are informed that the site proposed can be obtained either by purchase or on a Crown building lease.

"The plan attached to the report shows the road of access from Whitehall to the river-side main road, and the site proposed to be taken (the Patent Office Library and Museum (marked A, and coloured red); also the land to be reclaimed by the embankment marked B. and coloured green) proposed to be reserved and appropriated for the extension of the museum in future years.

"The surplus income of the Patent Office, applicable to building, amounts in the aggregate to £129,000. The Commissioners of Patents do not propose to ask your lordships to apply for building purposes any portion of this sum which has already been received, and has formed part of the general revenue of the country, but merely that the surplus income of the present year (1862) and that of succeeding years should be applied for the purposes above enumerated.

"The surplus income of the present year (1862) is estimated at £40,000.

"The Commissioners of Patents therefore earnestly request that your lordships will be pleased to sanction the appropriation of the site proposed by them for the Patent Office Buildings; that your lordships will be pleased to give the necessary directions to her Majesty's Board of Works to obtain the proposed site, either by purchase or by a lease from the Crown, and to direct the architects to prepare the necessary plans, elevations, and estimates; and, further, that your lordships will be pleased to direct such plans, elevations, and estimates to be laid down before Parliament at the commencement of the ensuing session; and to apply for a vote for such proportion of the estimated cost of the buildings as may be required for the year 1862-5; and, should it be decided to purchase the land for the site, also to apply to Parliament for the sum of money necessary for that purpose, all such moneys to be repaid out of the surplus income for the current and succeeding years."

ON THE STABILITY OF VESSELS IN WATER.

By John W. Nystrom.

From the *Journal Franklin Institute.*

This subject is discussed in almost every work on ship building, but in most cases so complicated that it requires a scientific man to understand it. I have frequently been consulted on the subject, and considering its great importance in the new era of naval architecture, have written this article, which I have endeavoured to make as simple and practical as possible. I will not here enter into any proofs of the formulas, which would render the article too long and tedious, but will only give the conclusive substance which bears directly on practice.

In constructing iron-clad vessels, it is difficult to bring down the centre of gravity low enough to make a good sea-going vessel, where the momentum of stability must be in a safe proportion to its sailing momentum.

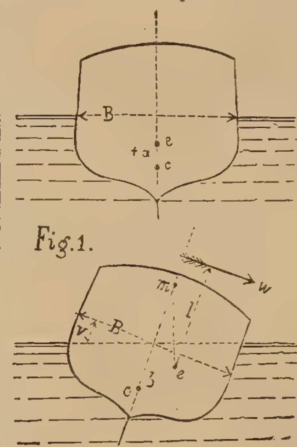


Fig. 1.

$$b = \frac{D\,B^3 \tan. v}{772^*\,D\,\Theta^2} \text{ .... } 1$$

$$W\,l = D\,(b \pm a \sin. v) \text{ .... } 2$$

$$\text{Metacentre } m = b \cot. v \text{ .... } 3$$

$$\text{Depth } \delta = d \cos. \tfrac{1}{2} v \text{ .... } 4$$

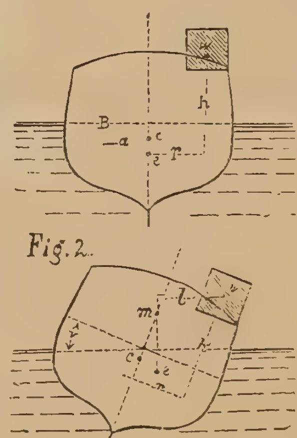


Fig. 2.

$$\pm a = \frac{1}{\sin. v.}\left(\frac{W\,l}{D} - b\right) \text{ .... } 5$$

$$l = \sin. v\,(h - r \sin. v) + r \sec. v + b \text{ ... } 6$$

$$\cot. v. = \frac{D}{W\,l}\left(\frac{D\,B^3}{772^*\,L\,\Theta^2} - a\right) \text{ .... } 7$$

$$\text{Capsizes when } a \sin. v = \text{ or } > b \text{ .... } 8$$

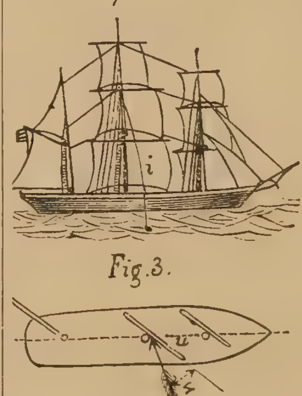


Fig. 3.

$$\text{Careen force } W = f\,A \sin. z \cos. u \text{ ...... } 9$$

$$\text{Sailing force } F = f\,A \sin. z \sin. u \text{ ...... } 10$$

$$\text{Miles per hour } M = \sqrt{\frac{F}{6\,\Theta}} \text{ .... } 11$$

$$\text{Force of wind } f = \frac{4\,\Theta\,M^2}{A \sin. z \sin. u} \text{ ... } 12$$

Definition of Letters.

D = displacement of the vessel in pounds.
Θ = greatest immersed section in square feet.
B = breadth of beam in feet in the water-line.
L = length of the vessel in feet in the water-line.

* 772 for salt and 750 for fresh water.

a = the vertical distance in feet between the centres of gravity of the vessel and displacement when in equilibrium. When the centre of gravity of the vessel c is below that of the displacement e, as in fig. 1, then a is positive, or $+ a$; and when c is above e, as in fig. 2, a is negative, or $- a$.

b = horizontal distance in feet from the centre of gravity of the displacement when in equilibrium to the same centre when out of equilibrium.

c = centre of gravity of the vessel.

e = " " displacement.

d = depth of the centre of gravity of the displacement under water-line in feet when in equilibrium, and

δ = depth of the same centre when out of equilibrium.

f = force of wind in pounds per square inch. (See Nystrom's Pocket Book, page 233.)

h = vertical height in feet from the centre of gravity of the displacement to the centre of the weight W, fig. 2, when the vessel is in equilibrium.

r = horizontal distance in feet from the centre of the vessel to the centre of the weight W, fig. 2.

l = leverage in feet, upon which any force acts to careen the vessel, to be calculated from the centre of gravity of the displacement, perpendicular to the direction of the careening force. In sailing, l is taken from the centre of gravity of the displacement to the centre of effort of the sails.

m = vertical distance in feet from the centre of gravity of the displacement when out of equilibrium to the metacentre m.

v = careen angle of the vessel.

u = angle of the sails to the length of the vessel.

z = angle of the wind to the sails.

Θ = area of resistance of the vessel in square feet. (See Nystrom's Pocket Book, page 233.)

A = area of all the sails in square feet.

M = miles or knots per hour, by sailing.

F = force in pounds acting to propel the vessel forward.

W = any weight or force in pounds acting on the lever l, to careen the vessel.

EXAMPLE 1. The U. S. steam frigate *Niagara* is L = 329 feet long, B = 55 feet wide; greatest immersed section, Θ = 855 square feet; displacement, D = 11,200,000 pounds; vertical distance between the centres of gravity of displacement and vessel assumed to be $- a$ = 2·5 feet. What momentum ($W l$ = ?) is required to careen her to an angle of $v = 8°$, and what force (W = ?) is required on a lever of l = 35 feet?

$$\text{Formula 1.} \quad b = \frac{11,200,000 \times 55^3 \times \tan. 8°}{772 \times 329 \times 855^2} = 1·414 \text{ feet.}$$

The required careen momentum will be

Formula 2. $W\,l = 11,200,000\,(1·414 - 2·5 \sin. 8°) = 11,940,320$ foot pounds, and the

$$\text{Force } W = \frac{11,940,320}{35} = 341,152 \text{ pounds} = 152 \text{ tons.}$$

EXAMPLE 2. It is required to find the momentum of stability of a man-of-war, by moving a number of guns of known weight from one side to the other. Each gun weighs 25,000 pounds, and four guns are moved to the opposite side, r = 20 feet from the centre of the vessel; the height of the centre of gravity of the guns above the centre of gravity of displacement is h = 16 feet. There will be eight guns of 25,000 pounds, or W = 200,000 pounds careen weight on one side, by which the vessel is careened to an angle of $v = 7° 20'$. Dimensions of the vessel are D = 6,150,000 pounds, B = 40 feet, L = 260 feet, and Θ = 566 square feet. Required the vertical distance between the centres of gravity of the vessel and displacement, a = ?

$$\text{Formula 1.} \quad b = \frac{6,150,000 \times 40^3 \times \tan. 7° 20'}{772 \times 260 \times 566^2} = 0·788 \text{ feet.}$$

$$\text{Formula 6.} \quad l = \sin. 7° 20' \,(16 - 20 \times \sin. 7° 20') \times 20 \sec. 7° 20' \times 0·788 = 22·666 \text{ feet.}$$

$$\text{Formula 5.} \quad < a = \frac{1}{\sin. 7° 20'}\left(\frac{200,000 \times 22·666}{6,150,000} - 0·788\right) = -\,0·698 \text{ feet.}$$

$$a \text{ is negative when } \frac{W\,l}{D} < b.$$

EXAMPLE 3. A sailing vessel of D = 1,792,000 pounds, Θ = 245 square feet, B = 27 feet, L = 175 feet, area of resistance Θ = 27·4 square feet, (see Nystrom's Pocket Book, page 233,) area of all the sails A = 6100 square feet, centre of effort of the sails above the centre of gravity of displacement l = 36 feet, $a = -$ 1·25 feet, angle of sails to the vessel $u = 35°$, angle of wind to the sails $z = 40°$. Required the careen angle v = ? and sailing speed M = ? in a high wind of f = 9 pounds per square foot.

$$\text{Formula 9.} \quad W = 9 \times 6100 \times \sin. 40° \times \cos. 35° = 28840 \text{ pounds.}$$

$$\text{Formula 7.} \quad \cot. v = \frac{1792000}{28840 \times 36}\left(\frac{1792000 \times 27^3}{772 \times 175 \times 245^2} - 1·25\right) = 5·37 = \cot. 10° 30' \text{ the angle required.}$$

The sailing force will be

$$\text{Formula 10.} \quad F = 9 \times 6100 \times \sin. 40° \times \sin. 35° = 20170 \text{ pounds.}$$

From which the sailing speed will be

$$\text{Formula 11.} \quad M = \sqrt{\frac{20170}{6 \times 27·4}} = 11 \text{ knots per hour.}$$

ABSTRACT OF ENGINEER'S LOG OF THE "GREAT EASTERN." SIXTH VOYAGE FROM LIVERPOOL TO NEW YORK, AUGUST, 1862.

Date each day, ending at Noon.	PADDLE ENGINES. Revolutions of Engines each day.	PADDLE ENGINES. Average Revolutions per minute.	PADDLE ENGINES. Average Pressure of Stm. in Engine-room.	PADDLE ENGINES. Tons of Coal used each day.	SCREW ENGINES. Revolutions of Engines each day.	SCREW ENGINES. Average Revolutions per minute.	SCREW ENGINES. Average Pressure of St'm. in Engine-room.	SCREW ENGINES. Tons of Coal used each day.	Total quantity of Coal used each day.	Number of Knots run by Paddle Engines.	Number of Knots run by Screw Engines.	Distance run by Ship in Knots.	Latitude.	Longitude.	Course.	Barometer.	Observations on Rolling of Ship. Inclination to windw.	Observations on Rolling of Ship. Inclination to leeward	Observations on Rolling of Ship. No. of oscil. per min.	General Remarks.
			lbs.	Tons			lbs.	Tons	Tons	K.	K.	K.				inches.	deg.	deg.		
August 17	11,519	9·04	21·0	133	42,230	34·5	$18\frac{1}{2}$	162	295	276	303	282	...	...	...	30·20	0	0	0	At 2.45 P.M. Started engines a-head slow. At 2.50 P.M. full speed. At 3.45 P.M. stopped engines to discharge pilot off Bell Buoy. At 4.30 P.M. full speed.
August 18	13,325	9·56	21·0	133	48,550	34·0	$17\frac{1}{2}$	160	293	339	352	295	51·8 N.	16·25 W.	W. ¼ S.	30·20	0	0	0	
August 19	13,626	9·4	21·0	139	52,995	34·0	$17\frac{1}{2}$	163	302	343	356	334	50·25 N.	25·7 W.	W. ½ S.	30·26	5	7	5	Stopped paddle and screw engines 45 min. to replace 2 broken bolts of Way Shaft.
August 20	13,229	9·1	21·0	139	49,160	34·0	18	165	304	325	355	250	50·00 N.	29·45 W.	W. ¼ S.	30·27	2	3	5	Strong N.W. gale and heavy head sea.
August 21	13,989	9·6	$21\frac{1}{2}$	140	50,090	34·0	$17\frac{3}{4}$	171	311	347	360	285	49·9 N.	37·14 W.	W. ¼ S.	30·26	5	5	6	Strong N. W. by W. gale and heavy head sea; coals good.
August 22	14,089	9·63	$21\frac{1}{2}$	140	48,690	34·0	$18\frac{1}{2}$	171	311	347	357	254	48·40 N.	43·41 W.	W. ½ S.	30·20	8	10	6	Strong W. N. W. gale and heavy head sea running.
August 23	15,588	10·5	$21\frac{1}{2}$	144	51,340	35·0	$17\frac{3}{4}$	165	309	383	374	298	47·20 N.	51·2 W.	W. by S.	30·50	7	7	6	Strong N. W. gale and heavy sea.
August 24	14,453	10·0	$21\frac{1}{2}$	144	49,050	34·0	$18\frac{1}{2}$	168	312	361	357	280	45·37 N.	56·30 W.	Various.	30·20	5	6	$5\frac{1}{2}$	At 8.40 P.M. half speed; at 10 P.M. off Cape Race; at 10.30 P.M. full speed.
August 25	15,178	10·4	$21\frac{1}{2}$	144	50,100	34·5	$17\frac{1}{2}$	168	312	378	363	295	43·44 N.	62·32 W.	S. W. by W. ¾ W.	30·50	4	3	5	Strong head wind and heavy head sea.
August 26	16,169	11·11	20·0	144	49,690	35·0	17	168	312	397	370	304	41·21 N.	62·32 W.	S. W. by W.	30·20	$3\frac{1}{2}$	$3\frac{1}{2}$	5	Strong head wind.
August 27	9,680	11·5	20·0	84	29,820	35·0	$17\frac{1}{2}$	98	182	240	218	200	Steering by	the land.		...	...	...	...	At 2.15 A.M. stopped engines off Montauk to take pilot on board; at 2.30 A.M. full speed; all particulars of engines taken up to this time, afterwards the engines working easy up to our moorings; dropped anchor at 12 noon.
Total	150,845	10·0	21·0	1484	521,715	34·5	17	1759	3243	3736	3755	3077	...	...	...	...	...	...	...	

Actual time steaming from Liverpool to New York, 10 days 13 hours.

Density of water in boilers, $1\frac{5}{8}$; vacuum in paddle engines, 25; vacuum in screw engines, 25·5; extreme diameter of paddle wheel, 50ft.; effective diameter 48ft. = 150·79ft. each revolution; pitch of screw, 44ft.; knots run per hour, 12·16; immersion on leaving Liverpool, 26ft. forward,—aft, 26ft.; slip of paddle wheels, 17·5 per cent.; slip of screw, 18 per cent.; average daily consumption of coals by paddle engines, 140 tons; ditto by screw engines, 161 tons; total daily consumption of coals 301 tons.

(Signed) J. RORISON, Chief Engineer.

ON THE ERIE EXPERIMENTS ON STEAM EXPANSION BY U.S. NAVAL ENGINEERS.

By Samuel McElroy, C.E.

(*From the Journal of the Franklin Institute.*)

During a part of the months of November and December, 1860, and January, 1861, experiments were made at Erie, on the U. S. steamer, *Michigan*, under order of the Secretary of the Navy, by a Board of Chief Engineers of the Naval Engineer Corps, to determine certain questions in reference to the economy of steam expansion. Previous experiments made by the chief officer of the Board had induced him to assert the fallacy of the commonly received doctrine of economy in expansion, and these observations were undertaken to pursue the investigation on a more perfect engine, and with greater care. A report of the results has been published by the Navy Department, of which a synopsis at length is given in the April number of this Journal, by a member of the Board.

The conclusions reported by this Board are of a very radical and revolutionary character, so far as they affect principles which have been accepted in practice from a very early period in the history of the steam engine applied to actual work. They differ from the whole tenor of experimental observation and theoretical deductions, and, if accepted by the profession, would modify at once our proportions of working parts, and our applications of power. Their argument as to the economy of expansion is contained in the following quotation from the report:—

"The results obtained from this engine are rigorously applicable to all others in which saturated steam is employed in a cylinder not steam jacketed, and show conclusively the utter futility of attempting to realize an economical gain in fuel under such conditions by expanding the steam beyond the very moderate limit of one-and-a-half times; and that, if the expansion be carried to three times, a positive loss is incurred. Also, that if measures of expansion as high as those due to cutting off the steam at $\frac{1}{6}$th or $\frac{4}{45}$ths of the stroke are employed, the economy is considerably less than with steam used absolutely without expansion." It is also stated, in those cases where a reduction is to be made in power, on a cylinder cutting off at the "economical limit of $\frac{7}{10}$ths," that, as to a choice between a closer cut-off and the use of the throttle, "in fact, the two modes of reducing the power may be considered equal in rapport of economy of fuel; but, in every other respect, the choice is immeasurably in favour of the throttle valve."

Language of this kind admits of no misconstruction. It throws the gauntlet at the foot of universal professional opinion and practice boldly and unequivocally. It declares that in all ordinary working cylinders, not steam jacketed, there is no gain in cutting off closer than two-fifths, and that a positive loss follows a cut-off at one-quarter stroke. It is better to carry full steam, we are told, than to cut off at one-sixth. And farther than this, it is better to throttle the steam for any reduction inside of seven-tenths cut off, than to cut off with the main valve.

An opinion of this kind, expressed in this way, has a certain gravity, and merits an attention which might be denied the publication of any individual conclusion to the same effect. It claims to be issued by authority, it involves the honour of the Naval Engineer Corps, it passes out to other countries as the conclusion of American science, and it pretends to be infallible. This Board informs us that its report is "only one more illustration of the well-known fact that the histories of all sciences are but records of mistakes and misconceptions, arising from the application of fallacious theories, which, once plausibly advanced, were long believed in, from an unwillingness to investigate for ourselves, but which exploded at the first touch of the *experimentum crucis*." It is a matter, therefore, of some interest to the profession to inquire how far this assumption of new light will in itself bear the test which is claimed to have been applied, for the first time, to all the past.

We may justly, then, in our examination of these opinions and the experiments on which they are based, subject them to severe analysis, in order to detect any sources of error. All revolutions, political or scientific, must be content to bear the burthen of proof, and cannot be allotted the benefit of any doubts. If, in ordinary processes, according with established principles, we may leave unquestioned between the initiative and the final result many of the intermediate operations, it is manifest that nothing of the kind can be claimed or allowed in a case like this, which seems to controvert well-known and long-established mechanical laws. And we have, therefore, a right to determine that this report shall only be accepted, if its experiments were correct as to the principle of experiment, the method of experiment, and the most consistent and conclusive results of experiment. Any contradictions occurring at any stage of the process, any palpable or possible errors in process, any anomalous results or inferences, are fatal to the whole, and must be so received. The first great lesson which a thorough-bred engineer learns, is to take nothing for granted; and however we may personally respect and value the character and experience of the members of this Board, we must judge of their verdict by fixed and positive conditions of analysis, and in no other way. If they have failed to determine with rigid accuracy a single important link in the chain of evidence, the report falls to the ground; and if processes in detail are suppressed, requisite to establish evidence, the argument of the report is, so far, vitiated.

The reader of this report cannot fail to be impressed with its parade of accuracy. Elaborate descriptions are given of certain precautions taken, and sizes in close detail of the boilers and engines are recorded with interesting fidelity. The precise number of inches between the bottom of the feed-water tank and the floor is not omitted. Equally elaborate are the arguments on the results obtained, both which features comprise a report of some 38 pages. But when, with some educated regard for such matters, we examine this report for the *notes of the experiments* in similar satisfactory detail, we are surprised to find them entirely omitted, and have no key to them whatever, except the aggregated results given in two tables, arranged in seven columns, allotted to as many distinct experiments. These tables are merely averages and aggregates of the results in detail, and therefore define the several processes in a general way. To have known precisely the times and manner of coal supply, tank supply, cleaning fires, starting and hauling fires, variations of pressures, and the like, as to the boilers, we might well have excused an elaborate notice of the kind, material, and diverse sizes of their flues, or any other matters irrelevant to the questions at issue. And this remark is applicable to all the other processes tabulated. The counsel for the defendant has no opportunity to cross-question the witnesses. The argument is confined to the general allegations. We do not mean to convey the impression here that these tables are incorrectly reported, but we do intend to say, that the report has a pretension of accuracy in detail which is not warranted by its actual statistics of essential points. It does not enable us to decide any questions suggested by the tables themselves.

The correctness of the opinions expressed by the Board is to be judged by the results obtained by it, so far as the course of examination adopted was in itself correct. If any objections exist as to any portion of such course, they invalidate, in proportion to their character, the results obtained. The first point, then, to be considered, is the Course of Experiment pursued.

The following general description of method is deduced from the statements of the report:—

The ship has two engines and two boilers. The starboard engine and both wheels were used, with *both boilers*, for all the trials reported, the port engine being disconnected.

The boiler evaporation was determined by indicator cards taken hourly, and by tank measurements.

Each experiment continued precisely 72 hours; there being 7 reported with a steam travel in the cylinder varying from $\frac{11}{12}$ths to $\frac{4}{45}$ths.

The boiler pressure was nearly uniform in all the trials.

The ship was secured to the wharf, so that the wheels paddled the water aft.

Before an experiment, the engine was operated for several hours. When all was ready as to water level and boiler pressure, with "average fires," the notes were commenced. At the close, the boiler level was corrected, and the fires made the same "as nearly as could be estimated." The friction and resistance of the engine and wheel-arms and rims were determined by taking off the floats, and working the engine from 6 to 22 turns, taking indicator cards to obtain a reliable mean for each rate of speed.

During an experiment, the engine was neither stopped, slowed down, nor in any way changed in condition.

Due precautions were taken as to the tightness of valves, &c., correctness of counter, coal account, and other important notes.

To illustrate more fully the course of experiment adopted, the following abstract is made from table No. 1 of the report, which gives the "data and results." Table No. 2 equates these results in various ways, and is based on No. 1:—

Date of commencement.	Boiler gauge pressure.	Mean cylinder pressure.	Vacuum.	Cut-off.	Revolutions.	Horse-power.	Coal per sq. foot of grate.	Coal per horse-power per hour.	Feed-water per lb. coal by tank.	Kind of Coal.
Dec. 30, 4 a.m.	21	19·9	25·8	3-10	13·69	133·7	6·28	4·23	8·33	Ormsby.
Jan. 2, 4 „	21	13·6	25·6	1-6	11·17	74·5	3·79	4·58	8·09	Ormsby.
Jan. 5, 6 „	21	17·4	25·8	1-4	13·87	118·4	5·21	3·96	8·70	Ormsby.
Jan. 8, 10 „	21	24·1	26·3	4-9	17·28	204·4	9·51	4·19	7·90	Ormsby.
Jan. 18, 10 p.m	19·5	27·6	26·1	7-10	15·56	210·8	11·41	4·87	7·14	Anthracite.
Jan. 21, 12 „	21	29·8	26·5	11-12	20·61	301·4	18·52	5·53	7·22	Brookfield.
Jan. 25, 6 „	22	8·8	24·1	4-45	14·10	60·9	4·11	6·08	7·58	Ormsby.

Notwithstanding the claim of this report that it is the "*experimentum crucis*" which has, for the first time, successfully opposed rigid experiment against "fallacious theories," we shall assume here, that there are certain general principles by which its particular course is to be tested, which overrule any experimental results, and decide the question of acceptance or rejection by positive laws.

We shall not pause here to defend this assumption by any argument at length. It is a great mistake to assert, in these latter days, that engineering is a science hitherto purely theoretical. On the contrary, it is clear that its laws have been gradually determined from the absolute results of long continued observations, and eliminated from the unmistakable precepts of actual trial. This is the glory of the profession, that from known results it has framed its precepts and laws, under the guidance of which, in certain established methods, it may claim infallibility, without arrogance. And it is the leading principle of the profession, that all conjecture and discussion should be brought to the test of trial and by such test to stand or fall. There is no need of multiplying words or adducing evidences of so well known a statement as this. Every engineer who has had to assume the responsibility of important constructions knows by experience that it is true.

As appears from its report, the Board, in experimenting, adopted a uniform standard of low boiler-pressure for all the variations of work, and changed the resistances of the wheels by removing the floats. For all grades of expansion then, low steam was used, a uniform initial pressure, and variable resistances.

We object to the correctness of this method, for the following reasons:—

The problem which presents itself to an engineer in operating his engine and his boilers is defined by the amount of work to be done and the most economical method of doing it within limits of safety. And with a given engine in place, like the *Michigan's*, the argument between expansion and non-expansion should have been determined by a fixed standard of piston resistance, and not by a fixed standard of boiler pressure, with variable resistances. Viewed in this light, which is the only correct one, the mission of this Board was to experiment, first on such a boiler pressure as with a full steam stroke would fulfil the usual duties of the engine, and then, maintaining the same *average cylinder pressure*, and the same engine duty, to test the economical results with successive degrees of expansion, and corresponding increments of initial pressure. This is the real matter at issue—whether it is cheaper to carry high steam and expand, or to carry low steam and follow at full stroke.

As to its opinion on this subject, the Board, in a part of its report, leaves us distinctly to infer that its results, as tabulated, are conclusive against the use of higher steam. Its argument, as given on pages 33 and 34, is based on the assumed fact that it has demonstrated an immense loss in any high range of expansion, and it follows by consequence, that a greater boiler pressure, as involving a closer cut-off, would be useless. Unfortunately for our confidence in its tables, which will not be found to bear analysis, it has not favoured us with any practical demonstration of its singular logic, and as it seems to be simply Quixotic to pause here, for the purpose of establishing the proposition which is plain to the rudest coal-heaver, that it is cheaper to make high steam than low steam, we content ourselves at present with saying that this neglect, in itself, as a misapprehension of principle, is sufficient to overthrow all these carefully eliminated tables and high toned results. The relative economy of high and low pressure for a given amount of work has long since passed beyond the region of conjecture. Those of us who have seen engines of enormous contract value, hanging for acceptance or rejection on the rise of the boiler gauge, and the curve of an indicator card, know something of this in practice, and by demonstrations of the highest order.

Again, we find in these experiments, that with the same pressure and the same grate surface, the rate of combustion in the boilers varies from 18·52 pounds per square foot to 3·79.

In this way the Board disposes in a very summary manner of the discussion which has long agitated the engineering world, as to the relative merits of quick and slow combustion. While one class has claimed superior advantage in slow combustion, and has specially adapted its boilers to this process, their opponents pronounce in favour of quick combustion, and modify their forms accordingly. The discussion also embraces varieties of coal, one being deemed most suitable for a slow fire, and another for a stronger fire. Volume after volume, experiment after experiment, debate after debate, are extant on this subject. But here, without argument or apology, this "fallacious" range of opinion is laid upon the shelf, and in the same boilers, with the same variety of coal, the rate of combustion is varied about *four hundred* per cent.! And the highest rate is that required, of all these, for the ordinary speed of the ship, for which these boilers were proportioned. The tabular results of this board, then, are just as valuable and just as conclusive on the theory of variable combustion as they are on that of variable expansion.

It has been claimed, and demonstrated by experiment in important cases, that the proportions and conditions of a boiler being constant, there can be but one rate of combustion in correspondence with its *maximum useful effect*. This is a recognised law of practice, and is true of either a quick or slow combustion boiler. Farther than this, it has been claimed, that the *useful effect* of a boiler is modified by the manner in which its steam supply is taken, whether more or less rapidly, and in approximation to a certain rate of supply. But the course of experiments under examination exercises a supreme contempt for these distinctions. Not only is the rate of combustion varied, as we have stated, but the rate of steam supply, in equal times, varies *six hundred* per cent.! The performance of these boilers, judged by the results tabulated, does not reach, by at least 25 per cent. of evaporation, the standard of reasonable expectation, and in no two experiments is the evaporation alike per pound of coal. When we are told that special care was exercised in all the experiments to keep the throttle open, although the Board claims to have demonstrated certain singular conclusions about throttling, we can readily understand with what ingenuity these boilers were themselves throttled out of their vitality.

The doctrine of *maximum useful effect*, which defines the load and velocity of an engine, is also placed at issue here. Theory has been confirmed, in repeated instances, as to this law, which has engaged the attention of our most profound students. A certain standard of proportion exists between the leading features of an engine and the amount of labour it will best perform, and no violence can be done any of its conditions of service without detrimental results.

The steamer *Michigan*, as a case in point, was built for Lake service, with a certain proportion of machinery to her displacement and speed. From notes of her performance, we find that with a mean piston pressure of 18·44 pounds per square inch, she makes $18\frac{1}{2}$ revolutions per minute, and 10·4 statute miles per hour. As a side-wheel steamer, with two engines and two boilers, these are her ordinary conditions of work. But, in experimenting with her, all these relative proportions are violated. One engine is disconnected, and both boilers are kept under fire to supply the other, although with the same initial pressure the revolutions are varied from 20·6 to 11·17, and the mean pressure (a representative of the load) is changed from 29·8 to 8·8 pounds per square inch. And yet the Board seems to be under the impression that all these changes are compatible with a common standard of useful effect, and practically denies a most important principle of mechanical action. In this respect we are not prepared to concede its infallibility.

In connexion with this objection a question of fact arises, as to the literal accuracy of the report. The Board attempted to carry out a mistaken principle of trial by regulating the resistances of the wheels, so as to accommodate a uniform initial pressure, and it succeeded very completely in producing a variously diseased and incongruous action of the engine; but it is incorrect in asserting that it "was not in any way changed in condition" of motion during any experiment, inasmuch as the waves were affected by the wind, and the dip of the floats varied as the vessel alternately grounded or floated, and the floats themselves were, from time to time, broken by ice. These resistances, by consequence, could not have been uniform during any experiment.

A glance at the tabular synopsis sufficiently indicates the effects of these variable resistances. The results in action are much more diversified than the changes in rate of expansion, and are strikingly inconsistent. A mean pressure of 8·8 pounds produces 14·1 revolutions, while that of 13·6 pounds gives only 11·17 turns. We increase the pressure 60 per cent., and it reduces the speed 21 per cent. A range of 603 per cent. has been noticed in the quantity of steam used in a given time; there is a range of 240 per cent. in the mean pressures; a variation of 10 per cent. in the vacuum; of 84 per cent. in speed; of 390 per cent. in combustion; of 50 per cent. in coal per H.P.; of 22 per cent. in evaporation.

And the argument of the report is embarrassing in these conflicting cases. There stand the tables of the new law. Whatever opposes their "data" is "fallacious," and it is just as incontrovertibly true, that an increase of pressure will reduce speed in all engines not steam-jacketed, as it is that it is cheaper to follow full stroke than to cut off at one-sixth.

On page 13, the report states that "during all the experiments the throttle valve was kept wide open." On pp. 36 and 37, we have the argument, already quoted, that for anything below a steam travel of seven-tenths, it is "immeasurably" better to throttle than to use the main valve.

Here the Board, not having experimented, passes into the dangerous region of "fallacious theories," and jeopardizes its infallibility. Engineers are under the impression that the moment of final pressure determines the amount of steam expended during an engine stroke. And it is a simple mechanical impossibility that the same mean pressure in connexion with a given final pressure can be produced, where the throttle is used instead of the main valve cut-off. All experience goes to confirm the very plain principle that throttling reduces the initial range of pressure, and consequently the mean pressure, which determines the amount of work done, while the final pressure, which measures the cost of the work, remains constant in either method; and there is therefore a loss of power equivalent, at least, to such reduction of pressure. An assertion of opinion, like that quoted, coming from such a source, cannot but be regarded with surprise. Not only is it incorrect as to economy of fuel, but in all well arranged engines it is as easy to modify the cut-off gear as to change the throttle. There may be an exception in the case of those horribly proportioned guillotines with which the Navy steamers have been afflicted of late years; which have 6 inches clearance and 54 inches diameter for 32 inches stroke; which spin around sixty-five times a minute to achieve eight knots an hour; and of which an "assistant" stands in mortal fear, from the time they are "hooked on" until they happily break down, and are laid up for repairs.

It was to be presumed that the Board would trace their special theory through a regular series of demonstrations to a final conclusion in their method of experiment. But our table shows that no order of this kind was observed in the variations of expansion, as its report also shows that it argues on certain grades, which it did not test. Experiment No. 7 in date, as the greatest in grade, immediately succeeds that of the greatest steam travel, and the relative order of the series, in this respect, is Nos. 6, 5, 4, 1, 3, 2, 7, as distinguished from their dates. If the results obtained developed a regular series, we might be content to accept them, no matter in what order of precedence, but these are as irregular as their order of trial. The consumption of coal per H. P. per hour is thus reported; 3·96lbs. for $\frac{1}{4}$ cut off, 4·19lbs. for $\frac{4}{9}$ths, 4·23lbs. for $\frac{3}{10}$ths, 4·58lbs. for $\frac{1}{6}$th, 4·87lbs. for $\frac{7}{10}$ths, 5·53lbs. for $\frac{11}{12}$ths, and 6·08lbs. for $\frac{4}{45}$ths. Such a result as this, taken in connexion with the fact that the last trial shows about three times the combustion per H. P. due to some engines, it is a painful commentary on the method of experiment adopted.

We may also observe here, that a number of experiments were made at Erie, which are not given in the report. The Board convened Nov. 19th, and the first result tabulated bears date Dec. 30th, although notes of experiments on the 1st, 5th, 8th, and 10th are extant. Of these the Board remarks, that "it is useless to add any others (to those given) which *uncontrollable variations* in the conditions during their progress could lay open to a doubt," although they are said to have shown less effect from the measures of expansion. The inference to be drawn from this omission, on these grounds, is by no means an argument in endorsement of the report, nor does it sustain the general *modus operandi*. Details of experiments are not only suppressed, but whole experiments themselves, probably equal in number to those given, are also suppressed. The witnesses do not tell the "whole truth."

Nor does the text of the report accord with the "data" tabulated, in an important matter of fact like the following:—

On page 12, we are told that "Each experiment lasted 72 consecutive hours, during which the engine was neither stopped, nor slowed down, nor in any way *changed in condition*. In commencing an experiment the engine was operated for *several hours* to adjust it *to the normal conditions* required to be *uniformly* maintained during that experiment, and to bring the fires to steady action." But when we turn to the tables which form the basis of the text, we find that while experiment No. 1 terminated its 72 hours run at 4 a.m., Jan. 2nd, experiment No. 2 commenced at precisely the same moment. We also find that there was but two hours interval between experiments Nos. 2 and 3, and 5 and 6. In a simple matter of fact, then, three experiments out of the seven are open to discussion, as to the statements of the text.

But this is not the most serious point of this objection. It will be noticed that the combustion of coal per square foot of grate is 6·28lbs. for No. 1, and 3·79lbs. for No. 2; that the evaporation varies from 8·33lbs. per lb. of coal to 8·09; that the mean cylinder pressure (which reveals a varied resistance) changes from 19·9lbs. to 13·6, and the cut-off from $\frac{3}{10}$ths to $\frac{1}{6}$th, or as 18 to 10, and the revolutions from 13·69 to 11·77. Now we would like to be informed by what medium, unrevealed to ordinary philosophers, this Board was enabled to change the combustion of the boilers 51 per cent. in rate, at the tick of the second-hand which changed experiment No. 1 to No. 2, and by what process they defined all the other changes of resistance and methods of action, which clearly distinguish these experiments. Their special claims of accuracy cannot meet the argument of this self-evident tabular conviction.

The Board suppresses a number of experiments on account of "uncontrollable variations." In those which they present we find that there is a variation in the boiler pressure from 19·5lbs. to 22lbs. per square inch.

There is a variation in the vacuum from 24·1 to 26·5 inches.

There is a variation in the evaporation per lb. of coal from 7·14 to 8·70lbs. of water.

There is a variation in the coal used, three kinds being reported.

In matters of simple management like these, the discrepancies are inexcusable, and tend to complicate the results needlessly. Especially is it strange that different kinds of coal should be admitted under any circumstances, the variety used for the greatest steam travel differing from that in any other experiment.

TRIAL OF THE "BLACK PRINCE."

Saturday, August 30th, the day appointed for the trial of the *Black Prince* at full power, having been beautifully fine, with the wind light at N.E. off the land, and the water almost without a ripple, preparations were at once made for taking the ship to the trial ground. In weighing the anchor, however, considerable delay took place, in connection with the steam capstan, this time one of the rollers giving way. Eventually, however, the anchor was got up and stowed, and the ship reached the course just in time to complete the required six runs while the tide remained available for the purpose. Since the ship's partial previous trial, when she only realised a mean speed of 12·2 knots, she has been placed in dock and had her bottom thoroughly cleansed, and the weights on her safety valve also rendered equal to those carried by the *Warrior* on her trial. Under these circumstances, as both ships were built from the same drawings, and their engines were made in one shop from one set of patterns, it might reasonably have been expected that the speed of both ships would have been as nearly as possible equal; but the result of this trial has definitely proved the *Black Prince*, under present circumstances, to be fully a knot per hour inferior in point of speed to the *Warrior*. The results of the six runs of the *Black Prince* on Saturday were as follows:—

Run.	Time.		Speed in knots.	Steam.	Vacuum.		Revolutions of engines.
	Min.	Sec.			Forward.	Aft.	
1	3	58	15·126	21½	24	24	52
2	5	5	11·803	21½	24	24	52
3	4	5	14·694	21½	25	24	51½
4	4	55	12·203	21½	25	24½	51½
5	4	18	13·953	21½	24¾	24½	51½
6	4	35	13·091	21½	25	24½	51

Mean speed of the six runs, 13·317 knots.

After making the fourth run to the eastward the ship's course was made towards the Sandhead Shoal, off Ryde, to gain room in which to turn the ship for commencing her fifth run to the westward.

It may be as well to insert here, by way of comparison, the result of the *Warrior's* six runs on her trial of speed. They were at follows:—

Run.	Time.		Speed in knots.	Steam.	Vacuum.	Revolutions of engines.
	Min.	Sec.		lb.		
1	3	38	16·514			55
2	4	57	12·121			54
3	3	38	16·514	Equal	to	54½
4	4	50	12·413	*Black*	*Prince's.*	53½
5	3	43	16·142			55
6	4	47	12·543			53½

Mean speed of the six runs, 14·354 knots.

By a comparison of the two means it will thus be seen that there is a difference of speed against the *Black Prince* of 1·037 knots.

In seeking for the cause of this difference several may be found, which, together or separately, will give a satisfactory reason for the apparent loss, although it, at the same time, will leave the *Warrior* as undeniably the faster ship of the two. There is a difference in the pitch of the two screws of about seven inches, and, with the *Black Prince* altered to this extent, it is calculated that she would increase the revolutions of her engines from her *maximum* rate of 52 to 54, or, perhaps, 55, the *maximum* of the *Warrior's*, which would give her at the same time an increase of speed. Again, the *Black Prince* had on Saturday a mean draught of water of 7½ inches over that of the *Warrior* on her trial, the former drawing 26ft. forward and 27ft. 2in. aft, while the latter only drew 25ft. 6in. forward and 26ft. 5in. aft. This would necessarily add to the *Black Prince's* displacement and to the amount of resistance she would have to overcome in passing through the water. It will also be in the recollection of all those interested in such matters that before leaving the Clyde the *Black Prince* grounded and heeled over considerably, causing fears at the time that she had somewhat strained herself. We have before alluded to the slight disturbance in her upper port line, and there is little doubt that she has dropped slightly at each end since receiving her weights on board. If the form of her bottom is at all altered, here alone is a sufficient cause to account for the loss of a knot per hour of speed. Looking at all these causes, however, a selection can only be fairly made of the 7½ inches extra displacement, and the difference in the pitch of the two screws as the true sources to which must be ascribed the *Black Prince's* defeat. This extra displacement, however, deserves some consideration. No reason can be assigned, with any certainty of its correctness, for the *Black Prince's* draught of water exceeding that of the *Warrior*. Her auxiliary engines exceeded in weight that of the latter ship, but for this the *Warrior's* Rifle Tower, with its 35 tons of armour plates, more than compensated. The bottom of the *Black Prince* must therefore be sharper than the *Warrior's*, must be thrown out of proper form, or her bottom plates must be considerably the heaviest. Over so vast surface the thirty-second part of an inch would made a great difference in the ship's weight. One thing is certain—this loss of a knot per hour of the ship's speed under steam is not due to her machinery, which fully maintained, by its working on Saturday, the reputation of the eminent firm by whom it was manufactured. The loss, then, is due, in some form, to the ship's hull; and to ascertain positively whether it is owing to the ship's immersion, or to her form of bottom, it would be necessary to lighten her, trim her to the same draught as the *Warrior*, set her propeller exactly to the same pitch, and try her again at the mile under, as nearly as could be done, the same circumstances as attended the *Warrior's* trial. With reference to the speed of ships under steam generally, some misunderstanding appears to exist in the public mind. If a ship is stated to have made 14 knots at the measured mile many persons look upon this as denoting the ship's future speed at sea. Never was a notion more fallacious. From all speeds made at the measured mile 1½ knot may be deducted, the remainder giving the ship's best rate of speed at sea, with good fuel, clean fires, and the ship, in fact, "pushed" to do her best. Taking a ship's average speed at sea, two knots may be deducted from the measured mile rate. The reason of this is obvious. At the measured mile she burns the best picked fuel, her fires are attended by a body of experienced stokers from the steam factory of the dockyard, under their own foremen, and the trial is never made when important, like the *Black Prince*, except under the most favourable circumstances of weather. This explanation will account for the apparent discrepancy in the speed of the *Warrior* on her late run with the Lords of the Admiralty in their yacht *Osborne* down Channel, and what she realised at the measured mile. When the *Warrior* made her 14·354 knots at the measured mile her average sea speed was set down at 12½ knots, and this, with a clean bottom, there is no doubt is her true sea rate.

The *Black Prince* concluded her trial of speed, so far as at present arranged, on Monday, September 1st, at the measured mile in Stokes Bay, at reduced boiler power. The first trial was made with six out of her complement of 10 boilers, being six-tenths of her power. Four runs were made as under:—

Run.	Time.		Speed in knots.	Steam.	Vacuum.		Revolutions of engines.
	Min.	Sec.		lb.	Forward.	Aft.	
1	4	55	12·203	19½	26·75	26·5	43½
2	5	40	10·588	20	26·5	26·5	44
3	4	38	12·950	20	26·25	26	44½
4	5	43	10·495	20	25·25	26	45

Mean speed of the four runs, 11·663 knots.

Two runs were next made with four boilers, four-tenths of the ship's power, with the following results:—

Run.	Time.		Speed in knots.	Steam.	Vacuum.		Revolutions of engines.
	Min.	Sec.		lb.	Forward.	Aft.	
1	4	52	12·329	20½	27	27	40
2	6	31	9·207	20½	27	27	40½

Mean speed of the two runs, 10·768 knots.

The *Warrior*, on her trial with reduced boiler power on the 26th of October, 1861, realised a mean speed, with six boilers, of 11·040 knots. As previously observed, if the *Black Prince* was trimmed to the same draught of water that the *Warrior* drew on her trial of speed, and her propeller set exactly to the same pitch, the difference in speed between the two vessels would be found to be very slight. The *Black Prince* drew one inch less forward than on the previous trial. A fresh wind prevailed from the N.E., but was off the land, and the water being in consequence perfectly smooth, it had no prejudicial effect upon the ship; on the contrary, it was of service, as it assisted materially in keeping down the temperature of her engine-room and stoke holes.

On the 10th ult. another trial of this frigate with her screw at an altered pitch took place in Stokes Bay. On this occasion the pitch of the screw was 28ft. 6in. This alteration it was calculated would allow the engines to get away with an increased number of revolutions, develope their power to a greater extent, and give the ship an additional speed towards making up the deficiency of 1·037 knot by the result of her last full powered trial, as compared with the *Warrior's* average.

These anticipations were realised as regards an increase in the number of revolutions, and an increased development of power, but the question of speed remained in the same unsatisfactory state. On this occasion the draught of water was 27ft. 3in. aft, and 26ft. 4in. forward, being a greater draught of water than on her previous trial. The required six runs were completed with the following results:—

Run.	Time.		Speed in knots.	Steam.	Vacuum.		Revolutions of engines.
	Min.	Sec.			Forward.	Aft.	
1	3	58	15·126	23·5	23	23	$55\frac{1}{2}$
2	5	6	11·765	24·5	23·5	23·5	56
3	3	54	15·384	24·5	23·5	23·5	56
4	5	4	11·841	24	23	23	$55\frac{1}{2}$
5	3	54	15·384	23·5	24	24	56
6	5	3	11·880	24	23	23	56

Mean speed of the six runs, 13·584 knots. Indicated horse-power of engines, 6100; slip of the screw, $14\frac{1}{2}$ per cent. This shows an excess of indicated power of 540 horses over the *Warrior*, and also a superiority in the number of the engines' revolutions, the *Warrior's* maximum revolutions being 55, and her minimum $53\frac{1}{2}$.

TRIAL OF THE "RESISTANCE."

The official trial of speed of this frigate, the fourth of our iron ships in commission, took place on the 25th ult., at the measured mile in Stokes Bay, with both full and half power, and was attended with the most satisfactory results. The ship was got under weigh by half-past 10, and was found to draw 23ft. 9in. of water forward and 26ft. aft., a little more by the stern than her sister ship, the *Defence*, drew on her trial, her draught of water on that occasion having been 25ft. 5in. aft and 24ft. 3in. forward. A run out was first made as far as the Nab Light-vessel to secure the anchor and clear the fires, after which she was taken to the trial-ground to commence her runs at the mile with full boiler power. In making the runs to the westward the wind was on the ship's port bow, and on the returning run to the eastward on her starboard quarter. The six runs with full power were made with the following results:—

Run.	Time.		Speed in Knots.	Steam.	Vacuum,		Revolutions of Engines.
	Min.	Sec.			Forward.	Aft.	
1......	4	58	12·080	20lb.	24	$23\frac{1}{2}$	67
2......	5	17	11·356	"	"	"	$68\frac{1}{2}$
3......	4	43	12·721	"	"	"	68
4......	5	39	10·619	"	"	"	$68\frac{1}{2}$
5......	4	33	13·186	"	"	"	$67\frac{1}{2}$
6......	5	51	10·256	"	"	"	68

Mean speed of the six runs, 11·832 knots.

With half-boiler power, two runs were made as follows:—

Run.	Time.		Speed in Knots.	Steam.	Vacuum.	Revolutions of Engines.
	Min.	Sec.				
1......	5	6	11·764	20lb.	27	58
2......	6	41	8·977	"	"	58

Mean speed of the two, 10·370 knots.

These results give the *Resistance* a superiority in speed over the *Defence*—both vessels being of precisely the same build and dimensions, with engines manufactured from the same patterns—at full power of a quarter of a knot, and at half power of no less than 1·315 knots, the latter a very important gain. At the close of the runs at the measured mile the ship took several turns through Spithead to get up her steam again to full power, when she was tested in making circles to port and starboard, the two experiments having the following results:—With helm hard a-starboard, the rudder was hove over to an angle of $24\frac{1}{2}$ degrees in 40 seconds, with $3\frac{3}{4}$ turns of the wheel; the half-circle made in 3 minutes and 11 seconds, and the full circle completed in 6 minutes and 19 seconds, the revolutions of the engines being $59\frac{1}{2}$. With helm hard a-port the rudder was hove over to an angle of $24\frac{1}{4}$ degrees full in 38 seconds, with $3\frac{5}{8}$ turns of the wheel; the half-circle made in 3 minutes 17 seconds, and the full circle completed in 6 minutes 35 seconds, the revolutions of the engines being 59. The angles of the rudder obtained are very remarkable, as showing a greater power of wheel and tiller over the rudder than has ever yet been experienced in any of our large screw ships. This increased power is obtained by a simple alteration and addition to the wheel on a plan suggested by Mr. Robinson, assistant-master shipwright of Sheerness Dockyard, by which the spindle of the wheel is sufficiently prolonged to receive an additional wheel to the ordinary two, thus gaining great additional force with the tiller ropes. The tiller is a long massive piece of forged iron, standing out from the rudder-head fore and aft the ship, with a curve from the rudder-head to give it play round the screw well, and working over a quadrant which gives the angles of the rudder. So long as rudderheads, gudgeons, and pintles stand, this application of immense power to rudderheads may answer in getting the rudders of our screw ships hard over when required, but an application of steam power below the water line would be far more simple, efficacious, and free from all danger of accident. In testing the action of the machinery, and the control which could be possessed over its working by the engineer, the engines were stopped dead from full speed in 19 seconds from the time of moving the telegraph to give the order, were started again in 9 seconds, and when again at full speed were stopped and turned astern in 20 seconds. The indicated horse-power of the engines was 2·372, or nearly four times their nominal power. The propeller, like those of the other iron ships, is an improved Griffiths, of 18ft. diameter, and with a pitch of 21ft., having an immersion of its upper edge of 7ft. The temperatures were:—

	Engine-room.	Fore Stokehole.	Aft Stokehole.
	Deg.	Deg.	Deg.
At 11 o'clock	91	110	128
At 11·30.............	98	131	138
At 12	96	132	138
At 12·30......................	96	132	142
At 1............................	96	135	146

Under the cowl which admitted the air into the fore stoke-hole the temperature stood at 100 deg.

The *Resistance* was launched on the 11th of April from Messrs. Westwood and Baillie's yard, near Millwall. She is 292ft. in her extreme length, has a breadth of 54ft., a depth from her spar deck of $38\frac{1}{2}$ft., and is of 3668 tons, builders' measurement. Her rig, like her form of hull, is precisely the same as the *Defence*, with the exception that she carries in addition fore and main topgallant yards on sliding gunter poles, which certainly improve her appearance greatly aloft. For armament she carries on the upper deck two 110-pounder pivot Armstrong guns, two 25-pounder Armstrongs, two 32-pounder smoothbores of 45cwt., besides a 12-pounder Armstrong field-piece and smooth-bore brass pieces for boat service. On her main deck she carries six 95cwt. guns, throwing solid 68lb. shot, and four 110-pounder Armstrongs, all on sliding carriages with directing bars.

EXPERIMENTAL TRIALS OF MARINE SCREWS.

The *Shannon* screw frigate has now completed her series of seven trials between the Admiralty and Mangin screws. In all the details connected with the trials, care has been taken that each should take place under as nearly similar circumstances as possible to the other; consequently the powers of the propellers have been tested as fairly and as evenly as possible, in the sheltered position of the trial ground in Stokes Bay. The Mangin (French) screw has been looked upon with much favour, owing to the small aperture it requires for the well in the ship's stern as a "lifting" screw, and also from the very favourable reports which have been received in this country respecting its powers of propulsion in the ships to which it has been fitted in the French Imperial navy. As regards speed, a reference to the table below will show that the speed of the *Shannon* as given by the "Mangin" was above the average of ordinary screws; but this trial, on the other hand, was accompanied by so great an amount of vibration as must preclude the adoption of this screw for service in the English navy, with its existing arrangement of blades. These, four in number, are set in parallel pairs in close proximity to each other, and the peculiar feature in their working, which tells so much against the screw, is, that they lock the water between them and carry it round in a disc form in their revolutions, causing the vibration, and also the terrific thrashing of the water to which allusion was made in former ARTIZANS. In three of the subsequent trials, blades were cast on the Mangin pattern, but, instead of being fixed on the boss in parallel pairs, as with the Mangin, they were set single at equidistant intervals on a Griffiths boss, and were tested as screws of three, four, and six blades. The four-bladed trial took place on the 4th of May, and the result gave an increase of speed, with a less indicated horse-power, over the Mangin, and an almost total absence of vibration. In the next trial of these blades, six were fixed to the same boss, but, although the result was equally favourable as regarded vibration, there was a loss with respect to speed of about a quarter knot. The trial of three blades, which had been looked forward to with great interest, as the closing trial of the series, is fully detailed in its place. It may be stated that these blades, cast in the foundry of Portsmouth yard, differed slightly in form from the original Mangin blades, being twice the width of the latter, owing to their being set singly instead of in parallel pairs, and tapering slightly in their width from root and edge to their centre. They still, however, retain all the peculiar features of the Mangin proper, and can be called by no other name. The Admiralty common screw on its first trial was tested with its leading corners cut, and on its second and third with both corners cut. Its first trial gave the best results, both as regards speed and vibration, but it was inferior to the Mangin in point of speed, and to the four Mangin blades on the Griffiths boss both as regards speed and vibration. This trimming of the corners of the common screw is, however, an approach to the Griffiths form, and when the area of the reduced screw requires the portions removed from the edge of the blades to be added to their root, then the Griffiths patent compels the abandonment of the process. Three of the trials have been with blades cast on the Mangin pattern, and fixed at equidistant intervals in a Griffiths boss, the first of the three being with four blades, which was attended with excellent results both as to speed and vibration. The second was made with six blades, but the result, although equally favourable with the four-bladed trial as regarded vibration, gave a loss of speed. The last trial was with three blades, and the speed made by the ship contrasts very favourably with the other trials, but the ship exhibited a very large amount of lateral vibration, which was the more extraordinary, as with the four blades she exhibited very little movement of any kind. The day was wet, but there was little wind, with smooth water, so that the screw was tested under equally favourable circumstances with the others. The ship was about two inches deeper in the water than on any former trial. The column of water raised in the well by the working of the screw was considerably less than with the Mangin or with the four or six blades. Six runs were made at the measured mile, with the following results:—1. Time, 4 min. 40 sec.; speed in knots, 12·857; revolutions of engine, 54. 2. Time, 5 min. 49 sec.; speed in knots, 10·315; revolutions of engines, 56. 3. Time, 4 min. 38 sec.; speed in knots, 12·950; revolutions of engines, 56. 4. Time, 6 min. 1 sec.; speed in knots, 9·972; revolutions of engines, 56½. 5. Time, 4 min. 42 sec.; speed in knots, 12·766; revolutions of engines, 56. 6. Time. 5 min. 56 sec.; speed in knots, 10·112; revolutions of engines, 55½. Mean speed of the whole, 11·485 knots. The first circle was made to starboard in 7 min. 7 sec., with the rudder over to an angle of 15½ degrees. The second was made to port in 7 min. 31 sec., with the rudder to an angle of 14½ degrees, the revolutions of the engines being 56 and 54½.

The following tables will show the comparative results of each trial:—

No. and date of Trial.	Description of Screw.	Screw. Diamr.	Pitch.	Length.	Immer.	Revolution of Engines.	Steam Pressure.	Vacuum.	Speed of Ship in Knots.	Indicated Horse-power.	Time occupied in completing circle.	Angle of rudder in degrees.	Helm to
		Ft. in.	Ft. in.	Ft. in.	Ft. in.						min. sec.		
1. May 16	Common, with leading corners cut	18 1	25 3	3 6	1 0½	59·40	20	24	11·288	2054·8	7 43 7 24	12½ 14	Port. Starboard.
2. May 17	The "Mangin," having four blades set in parallel pairs	18 0	25 0	3 0	1 1	53	20	25	11·328	2032·72	7 14 7 1	13¾ 15½	Port. Starboard.
3. May 19	Common, with both corners cut	18 0	24 11	3 0	1 0½	57·40	19·5	25	11·080	2093·92	7 43 7 33	13 15¾	Port. Starboard.
4. May 31	Four Mangin blades on a Griffiths boss	18 1¾	23 7½	2 3⅝	1 0	53	20	25	11·550	2020·86	7 12 7 50	13 13	Port. Starboard.
5. June 10	Common, with both corners cut, being a repetition of a former trial	18 0	24 11	3 0	1 0½	57·70	19·5	24	11·009	2031·68	7 50 7 20	Not taken.	Port. Starboard.
6. June 16	Six Mangin blades on a Griffiths boss	18 1¾	23 7½	2 3⅝	1 0	49·60	20	25	11·244	1946·73	7 8 7 57	14 13	Port. Starboard.
7. July 3	Three Mangin blades on a Griffiths boss	...	...	...	...	56	20	24	11·485	...	...	15½ 14½	Port. Starboard.

The *Shannon's* trials with the common screw in 1856 gave the following results in the speed of the ship and indicated horse-power of the engines:—

Date of Trial.	Speed of Ship in Knots.	Indicated Horse-power.
November 11th	10·492	1956·7
" 18th	11·216	1930·9
December 2nd	11·708	2114·0
" 3rd	11·499	2124·0
" 16th	11·688	2216·3

In point of speed, therefore, these trials stood in the following order:—December 2, December 16, December 3, November 18, and November 11. In point of economy, reckoning the horse-power per knot, as given by the indicated power, they, however, stand as follows:—November 18, December 2, December 3, November 11, and December 16. With the exception of the trials with the *Archimedes* in 1840, and subsequently with the *Rattler* in 1843-4-5, there has, however, been no series of trials equal in importance to those concluded by the *Shannon*, and the value of which will be still further enhanced by the supplementary trials by the same vessel ordered by the Admiralty with the Griffiths screw, with two, three, and four blades respectively. The further prosecution of the trials with a Griffiths screw of two, three, and four blades, has been postponed for the present, in consequence of the sailing of the *Shannon* for the Mediterranean. As her cruise is, however, intended to be only a short one, it is most probable that she will yet complete her experimental trials as was originally arranged.

The area and weight of each screw was as follows:—

No. of Trial.	Area in feet.			Weight. Tons.	cwt.	qr.	lb.
1	Of 1 blade Of the 2 blades	40·5 81·0	....	8	7	3	24
2	Of 1 blade Of the 4 blades	19·5 78·0	....	7	7	3	0
3	Of 1 blade Of the 2 blades	34·0 68·0	....	7	18	1	0
4	Of 1 blade Of the 4 blades	22·5 90·0	....	11	5	3	21
5	Of 1 blade Of the 2 blades	34·0 68·0	....	7	18	1	0
6	Of 1 blade Of the 6 blades	22·5 135·0	....	14	15	3	12
7	Of 1 blade Of the 3 blades	22·5 67·5	....	10	14	0	72

Obituary.

JAMES JOHN BERKLEY, M. INST. C.E. AND F.G.S.

The profession of civil engineering has to lament the loss of another of its eminent members in the death of James John Berkley, engineer-in-chief, in India, of the Great Indian Peninsular Railway. After a lingering illness contracted in India he died at his home at Sydenham, on August 25th, at the early age of 43 years. He was an accomplished man, and possessing more than ordinary engineering abilities. The late Mr. Robert Stephenson included him among his intimate and attached friends. Mr. Stephenson entertained so high an opinion of his talents and character as to associate him confidentially with his professional life, and at an early age to intrust him with the responsible office of chief resident engineer of the Churnet Valley and Trent Valley Railways. Under the advice of Mr. Stephenson he was appointed engineer-in-chief, in India, of the Great Indian Peninsular Railway, and in January, 1850, he commenced the important work of laying out and making nearly 1300 miles of railway. He was the engineer who constructed and opened the first Indian railway. At a time when the passage of locomotive engines up long and very steep gradients was deemed to be somewhat doubtful, Mr. Berkley designed the two great inclines over the lofty mountains (2100 feet high) of Western India, known as the Bhore and Thall Ghauts, and by which an uninterrupted communication will shortly be opened from Bombay, respectively to Calcutta and Madras. The boldness and skill displayed in the construction of these truly gigantic works are perhaps unsurpassed, and they are noble monuments of English engineering. Without sacrificing efficiency and durability in the execution of his works, Mr. Berkley was decidedly an economical engineer; he subordinated all interests to those of the shareholders, and it is not therefore surprising that his line—the Great Indian Peninsular—bids fair to be the cheapest and most profitable line in India. The employment of native agency in all branches of his works was a favourite and successful practice with him;

and although this might, in some degree, appear to explain his remarkable popularity with the natives in Bombay of all ranks, it was really by his conciliatory manner and continuous efforts for their good that he won their confidence and esteem. It was a favourite expression of George Stephenson's that he could engineer matter very well, but his difficulty was in engineering men. His son Robert Stephenson, on the occasion of presiding at a public dinner given to James Berkley in April, 1856, in London, said,—"He had succeeded not only in engineering matter in a foreign country, with few available resources for railway operations, but he had also been eminently successful in that more difficult task of engineering men," no small tribute to his talent and temper.

The death of J. J. Berkley is a loss not confined to his profession. At the present time, when Lancashire is starving for the want of cotton from India, the engineer who designed, and in spite of strenuous and prolonged official opposition, carried his railway from the Port of Bombay to the heart of the cotton-growing districts of Central India, can but be greatly missed in the sphere of his yet but partly completed labours.

Few people are, perhaps, aware that to Mr. Berkley's talents and professional influence alone must be attributed the construction of a direct line from the cotton districts to the port of shipment in India. And still fewer are aware that, had his advice been followed and his plans carried out, when first he urged the construction of that line, the great hindrance to an abundant supply of Indian cotton for our manufactures would not now exist—in point of fact, the Great Indian Peninsular Railway, to the centre of Berar, would now be opened. On the subject of Indian railways, Mr. Berkley's literary contributions to the Institute of Civil Engineers, and to the Mechanics' Institution of Bombay, are of a highly valuable and interesting character. The scientific papers which his large experience and ready pen could with facility produce, will be greatly missed by the profession, which must always especially regret the loss of those of its members competent and willing to contribute valuable information.

There exists amongst the natives of India a curious tradition, in some cases amounting to a custom, that the execution of any great work, in that country, must be at the cost of human sacrifice. The coincidence seems to be painfully true in the case of our own countrymen, so many of whom have fallen sacrifices in the execution of the several great public works they have constructed in India. Unlike, however, the superstitious sacrifices of the natives, ours have been made in the cause of civilisation, and for the good of mankind; and such sacrifices deserve, as they will always receive, the admiration we accord to acts of heroism, wherever achieved.

REVIEWS AND NOTICES OF NEW BOOKS.

The Resources of Turkey: "Considered with especial Reference to the Profitable Investment of Capital in the Ottoman Empire." By J. LEWIS FARLEY. London: Longman, Green, Longman, and Roberts. 1862.

THE Turkish Empire ought to be the very finest field for English enterprise amongst the foreign countries represented at the Court of St. James. Undoubtedly so long as the English and other Governments continue to bolster up the Turkish Empire, notwithstanding its gross internal maladministration, and they guarantee in some form or another to the foreign creditors of the Porte the repayment of such debts, or of the interest upon one foreign loan after another, the credit of the Ottoman Empire will be sustained in a position far above that which is justified, even with the prospects of the constantly promised economies and internal reforms being faithfully carried out; but the protection and aid thus afforded to the Porte continues to produce the greatest possible mischief, and retards or impedes that healthy action which would otherwise be set up if the Ottomans were made to feel the necessity for self-reliance, by our gradually ceasing to afford, instead of continually offering, financial assistance.

If this foreign intervention did no other or greater mischief to the Ottoman Empire than to produce a want of self-reliance in the administration of the finances of the country, and the consequent unhealthy condition of things invariably ensuing therefrom, it would, indeed, be bad enough; but its evils are more deeply seated, and threaten the disruption and dissolution of the Empire at no distant date. Advantage is taken by the Turks of the protective policy of the Christian guaranteeing powers—particularly England—to permit the most fanatical persecutions of the several Christian peoples in the several parts of the Empire, and provoke an amount of religious hatred on the part of the Musselman towards the Christian, which it is scarcely possible to conceive should exist in the latter half of the nineteenth century.

Until the Musselmen return into Asia and a strong Christian power be established in Turkey in Europe, the peace of the European Continent can never be secure for any period, assist as best we may in patching up for a time the differences which are continually arising between the Christian provinces of European Turkey and the Ottoman Government of the Porte.

The recent atrocious conduct of the Pasha and his Turkish force within the fortress of Belgrade, against the Christian inhabitants of the city, is a fair example of the relations of the Turk towards the Christian and other non-Musselman population under their rule in Europe.

The State Policy of Great Britain in relation to Turkey, is, without doubt, not only a political but a social blunder. Inspired by the dread of Russian encroachments, and the ultimate absorption of Turkey in Europe into the Russian Empire, or the establishment of a Russo-Greek Empire, and the consequently enormous augmentation of power which would in either case be given thereby to a rival, such as Russia, in Eastern Europe, would imperil our Indian and other possessions in the East, we maintain a semi-barbarous power, and uphold a religion, which in European Turkey, according to Mr. Farley, is professed by only about 4,500,000 of persons, out of a population of about 16 millions, and amongst those returned as professing Mahometanism are the inhabitants of whole countries who have nominally gone over from the Christian faith, and from Judaism, in consequence of the religious persecutions of the conquering or dominating race.

If instead of maintaining the Ottoman Empire in its present sickly condition, composed as it is—in Europe more particularly—of a number of non-coherent provinces belonging to and inhabited by Christian people, but under the military misgovernment and oppression of the Christian-hating Turk; a powerful independent Christian kingdom, or confederation was erected, the existence of which was recognised and guaranteed by the Western powers, no stronger, more effective, or less costly bulwark against the much dreaded encroachment of Russia, or of any other existing nation, could be formed; and certainly no course of policy more befitting so great a Christian nation as England, could be adopted.

Besides the alleged fears of the British government of Russian encroachments, and of the constant political intrigues which are alleged against them, the French, too, it is believed, come in for a share of the charge of political intrigue in European Turkish affairs; but English history proves, and every-day experience shews to those interested in European affairs, that there are not in the world greater intriguants in the political affairs of other nations than the employés abroad (official and non-official), of the English Department of State—the Foreign Office.

If with the English capital subscribed to the loans made to the Ottoman Government, an equal proportion of British commercial enterprise could be introduced, a more hopeful state of things might be looked for; and we agree entirely with the views which pervade Mr. Farley's book, that whilst Turkey affords an admirable field for the investment of British capital, it is not by loans to the Government of the Porte that the enormous resources of the Ottoman empire are to be soundly and rapidly developed, and its material progress best encouraged.

The publication of Mr. Farley's work is most opportune, and the statistical and general information it contains is of the utmost value to all who take an interest in the commercial and financial prospects of Turkey; and we have seldom or never found so much reliable information, collated as it is from official resources, and the result of personal observation, investigation, and study in the country, in a single volume dedicated to a description of the resources of a foreign country where the official collection of statistical information respecting trade and commerce is not practised by the Government.

Mr. Farley has not, as might be supposed by those to whom he is known, confined himself to financial matters and the statistics of commerce alone, but has given us some very interesting information connected with the industrial resources of the Ottoman empire. There is a chapter on the mineral resources, and one on the growth of cotton. Altogether, *Farley on the Resources of Turkey* is a most interesting and valuable book, the contents of which should be read and studied by British manufacturers and others engaged in industrial operations.

Col. Anderson, on the Manufacture of Gunpowder, with Notes and Additions by Lt. Col. Parlby, retired Bengal Artillery. London, published by John Weale, 59 High Holborn. 14s.

THE art of printing and the various applications of the powers of steam and gunpowder, have produced such remarkable influences on the progress of nations, that, whatever is new and instructive, published upon these subjects is welcomed by the public.

At the present day from the unfortunate prevalence of wars, and the necessity of national self-defence, the subject of cannon, fire-arms and gunpowder are of universal interest, and to those connected with the military profession, or to manufacturers of war materials are particularly so.

In the preface, the editor, Lieut. Col. Parlby, explains that the foundation of the book is derived from the meritorious professional labours of Col. Anderson, as an agent for the manufacture of gunpowder in Bengal, and details are given, fully explanatory of the manufacture of gunpowder, as pursued under that officer in India, which the editor has followed up by the details of the most approved practices at home at the present day; added to this information, there are details of experiments applied to cannon and fire-arms, patiently and extensively made, which to the professional reader, or those wishing to study the subject, are of great interest.

Besides these matters, which embrace the manufacture of gunpowder in all its branches, we find in the notes and additions, by the editor, who from long experience is well versed in the subject, some original information and much that throws a new light upon the circumstances attending the explosion of gunpowder in close chambers, and is well worthy the attention of artillerists.

In the paper "Inquiry into the chemical effects of fired Gunpowder," commencing page 217, we have an explanation of the vetarding causes of the inflammation in discharges of cannon, which we are not aware has been heretofore sufficiently attended to by writers on the subject; and the paper on the modern improvements in artillery and fire-arms is deeply interesting, and is calculated to awaken thoughts on the necessity of being well prepared before hand for the naval and land defence of our nation, in case of necessity, which sudden changes in the politics of nations might momentarily bring upon us.

There cannot be a doubt that the late experiments at Shoeburyness, with the Horsfall gun and the Whitworth shell, have proved the necessity of being provided with heavy ordnance in our batteries, beyond those which were formerly in use; and the suggestion which is given in page 249, that the old system of fortification must be abandoned has every reasonable argument to support it, and will, we trust, be properly considered in determining the construction of any new land defences.

The papers on the subject of charcoal, page 233, and the statement that the causes of atmospherical resistance to shot, depending more upon the friction on their surfaces, than on the diameters, which the experience of Mr. Whitworth, in obtaining from $\frac{1}{4}$ to $\frac{1}{5}$ more extended ranges, by using shot tapering to the rear, seems fully to confirm, are of too much interest to be passed without notice.

The paper on the war-rocket, page 270, is especially entitled to public attention.

It appears singular and unaccountable that an officer of the Indian army, should have been from his first endeavours to improve an Indian weapon so thwarted and opposed as Col. Parlby has been, and for so many years after he had given public and substantial proof that he had so far corrected the erratic character of the Congreve rocket as to give a precision of range to that formidable weapon which has not yet been obtained by the manufacturers in our Royal laboratory, having all the advantages of experienced workmen and superior machinery; but, when we reflect upon the delay that has taken place in the trial of the Horsfall gun, which has been neglectfully laid aside for six years, after being in possession of our government for that time, and all trial steadily and pertinaciously refused (a trial which would probably, had it been made in proper time, have saved a prodigious waste of public money, and insured the nation being provided with efficient cannon), we cannot be surprised at any neglect or tardiness in our public departments.

At any rate the formidable nature of rockets has been proved and admitted, all that is required is the correction of their irregularities of flight, their facility of transport, and the simplicity of their use, as the variety of their application in the main purposes of war cannot be disputed.

A great deal has been written by eminent engineers, Carnot and others, on the subject of the effect of vertical fire, but at page 281, Col. Parlby brings forward a mode of producing it, of the most formidable nature, by means of large rockets which no ship or garrison could withstand for a short time without destruction to their defenders; and the dismaying and destructive effects of volleys of rockets to bodies of cavalry may easily be imagined by the detail of the broken charge of a fine dragoon regiment from a volley of small paper rockets related in page 275.

We can only afford space to recommend the volume as worthy of a place in all military libraries, and hope that amongst the members of our patriotic volunteer corps it may have the full circulation it seems to merit.

Even in the concise history of the origin of gunpowders, at the commencement of the volume, there is much that is new to the English public, and the commentator on Shakespeare, at page 26, may find matter to satisfy his mind as to one of the expressions of our immortal bard. Mr. Weale has done well to bring out this interesting volume at the present time.

The Complete Measurer, &c. By Richard Horton. London: John Weale, 59, High Holborn. 1862.

A very handy book of tables for facilitating—

1st. The measurement of superfices from $\frac{1}{8}$in. to 72in. broad, and from $\frac{1}{4}$in. to 40ft. long,

2nd. Measurement of the surface of unequal-sided figures, of intermediate dimensions, up to $59\frac{1}{2}$in. by 60in.

3rd. The cubical contents of square-sided bodies, particularly timber, &c., from the smallest dimensions up to 50ft. long by $60\frac{3}{4}$in. in width, on the side.

4th. For showing the solid measurement of unhewn trees, &c., up to 50ft. long by $60\frac{3}{4}$in., taken on the quarter of the circumference.

5th. The solid contents of right-sided figures, as timber, stone, &c., up to 50ft. long by $30\frac{7}{8}$in. on the side.

There are also some instructions for measuring and valuing growing timber, trees, pollards, and saplings; and some miscellaneous remarks upon the precautions to be observed in girting timber, &c.

We have had occasion to refer to some of the tables since the book was received by us; and having tested them, we find them more correct than those we have hitherto used.

The Iron Manufacture of Great Britain, theoretically and practically considered. By W. Truran, C.E. Second Edition. Revised from the manuscript of the late Mr. Truran, by J. Arthur Phillips and W. H. Dorman, C.E. London: E. and F. N. Spon, Bucklersbury. 1862.

When Mr. Truran produced his work on the iron manufacture of Great Britain, in 1855, we looked upon it as the best book on that subject extant, although it certainly contained some views on practical and scientific questions which were considered as greatly at variance with the experience of some of the best reputed practical iron makers of the day. The appearance of a second edition of Truran's work, is, we believe, mainly, if not entirely, due to the enterprise of Messrs. E. and F. N. Spon, the publishers; as but for the manuscript and drawings prepared by Mr. Truran, whilst in Australia, having come into their possession—although in an imperfect state—the public might not have had the advantage of the scientific abilities of Messrs. J. A. Phillips and W. H. Dorman, which have been devoted to the arrangement of the textual matter, and the production of the numerous plates.

To inform our readers that the book under notice is considerably thicker than the first edition, and that it has eighty-four plates instead of twenty-three, as in the previous edition, would not convey to their minds what is really the case, viz., that the present edition is not only an extension of the former volume, but it bears evidence that to the careful manner in which it has been edited is, in a great measure, due the higher character the work now possesses as a standard book of reference on the Iron Manufactures of Great Britain.

The book treats of every detail connected with the arrangement, erection, and practical management of iron works, in the most minute and careful manner, and the various ores and the materials employed in reducing the ores, and in producing the metal in its various stages, up to the finished metal—in the forms of rails, merchant bars, rods, hoops, and plates—are most thoroughly and scientifically dealt with, and in the most intelligible manner brought before the reader.

The want of so complete and practical a work on this subject has long been felt, and its appearance must be hailed as most opportune, and of the greatest importance, as we believe, to the future more economical conduct and treatment of this grand national branch of industry.

With the American book by Overman—although it is written in a popular style, and is now somewhat out of date—the excellent elementary treatise on "Iron Metallurgy," by S. B. Rogers, and the highly valuable and magnificently illustrated work of the late W. Truran, just produced under the joint editorship of Messrs. Phillips and Dorman, all that can be desired in the way of information in connection with iron metallurgy and the manufacture of iron will be therein found, and with those books the library of the worker in iron may be said to be complete.

NOTICES TO CORRESPONDENTS.

B. N.—The instructions for using Hoare's slide rule, were published some little time since by Crozier, of Silver-street, Golden-square, under the title of *New Instructions, &c.* We believe Hoare's slide rule to be the best which has been introduced for the use of engineers and artizans.

B. J.—You are in error. Our Supplementary Exhibition Series is issued *separately*, and will be completed in six numbers.

R. F. H.—We will endeavour to answer your queries in detail in our next.

A. G.—The history of the Liverpool and Manchester Railway may be briefly stated as follows:—

The first idea of this undertaking originated as early as 1822, with Mr. William James, of London, a respectable surveyor, who, having witnessed the powers of the locomotive engines in the neighbourhood of Newcastle-upon-Tyne, conceived that it might be successfully employed on a railway for commercial purposes. The insufficiency of the existing modes of conveyance for the increased commerce of Liverpool and Manchester, and the monopoly enjoyed by the three great canal interests, namely, the Duke of Bridgewater, the Mersey and Irwell, and the Leeds and Liverpool Canals, induced several spirited gentlemen to patronise the scheme. Surveys of a line were accordingly made by Mr. James, but principally at his own expense. Mr. James's line presented many advantages, but it was not thought proper to adopt it, and, accordingly, another survey of a line, to the north of Mr. James's, was made in 1824 by Mr. Stephenson, and a bill brought into Parliament in the following session. A prospectus was issued, setting forth the superiority of railroads over every other communication, describing the direction and nature of the line, which was estimated to cost £400,000, pointing out the disadvantages of the existing modes of conveyance, and the immediate benefits likely to accrue to the proprietors and to the country at large, by the introduction of the locomotive engine, which was represented as a machine capable of developing the most extraordinary powers.

Such, then, was the scheme of the Liverpool and Manchester Railway, requiring, however, the sanction of the legislature before it could be carried into effect. The bill, however, met with the most strenuous opposition, every clause was disputed, when, after a discussion of thirty-seven days in the Committee of the House of Commons, it was thrown out, in consequence of errors in the sections and survey. Undaunted by this failure, the directors assembled their friends, discussed the objections, and finally determined upon applying once more to Parliament. Accordingly, early in July, 1825, Messrs. George and John Rennie were applied to, and the former of these gentlemen undertook the survey. On the 12th of August the Committee, on the recommendation of the engineer, determined to adopt a new line of way, passing considerably to the south of the former route. In furtherance of this resolution, Mr. Charles Vignoles, on behalf of Messrs. Rennie, was appointed to prepare the necessary sections and plans of the projected undertaking. Mr. Vignoles executed his task with much ability, and such was the activity employed by these gentlemen, that the levels and sections of the two former lines, together with every requisite information relative to the new line, were completed and deposited in little better than three months. The directors then issued a second prospectus, adverting to the causes which led to the unsuccessful termination of their former efforts, acknowledging the errors that had been committed in the sections and levels, and that to avoid all chance of similar complaint in future, they had engaged the services of Messrs. Rennie, whose combined efforts justified the fullest assurance, not only of the correctness of the plans and sections, but that the whole line was to be laid down with that skill and conformity with the rules of mechanical science, which would equally challenge approbation, whether considered as a national undertaking of great public utility, or as a magnificent specimen of art. The second objection to the measure was the interruption and inconvenience anticipated, from the line of road crossing various streets in Liverpool and Manchester. This difficulty was completely obviated by the new line recommended by Messrs. Rennie, which entered Liverpool by means of a tunnel and inclined plane, thus effecting a direct and most desirable communication with the King, and Queen's Docks. Various other advantages were pointed out by the new line, and as many objections had been made to the employment of the locomotive engines, the clause for using them was abandoned for the time, and every probable sacrifice, consistent with the furtherance of this great scheme, was made. In March, 1826, the measure was discussed with much opposition in a committee of the House of Commons, and carried by a majority of forty-seven. In the committee of the House of Lords the opposition was again renewed, but the measure was finally carried by a majority of twenty-eight. Such is a brief outline of the parliamentary proceedings on the Liverpool and Manchester Railway, a measure which called into activity very powerful and conflicting interests.

The directors having thus, through the instrumentality of Messrs. Rennie, concluded their labour, it was natural to suppose, that the execution of the undertaking would have been entrusted to them. The directors thought otherwise. The whole was most unaccountably taken out of their hands and again transferred to those of Mr. Stephenson. This transaction excited the astonishment and disgust of many of the proprietors, some of whom withdrew from the direction and others sold their shares. But the line had already been fixed by Parliament, and although some slight deviations, which could not be accomplished in the first instance, were afterwards made, the general plan of the undertaking, including the tunnel under the town of Liverpool, the cuttings and embankments in different parts of the line, the great viaduct over the Sankey Valley, the road over Chat Moss, together with the bridges both over and under the railway, are with a few exceptions, Messrs. Rennie's, and although attempts have been unjustly made to suppress the names of these gentlemen from all participation in this great work, the transaction is well known and duly appreciated by a large portion of the public.

MODE PROPOSED OF WORKING THE LINE.

The inclinations of the railway having been graduated for the employment of horse-power in lieu of locomotive engines. The dynamic effect of horse-power was adopted according to the late Mr. Tredgold's formula* at 125 lbs.. moving at the rate of 3 miles per hour for 6 hours.

The friction or resistance of the carriages on the railway $\frac{1}{180}$ of the weight, or the horse-power on an average was capable of transporting 10 tons for 6 hours per diem, or 180 tons one mile.

The distance was proposed to be divided into three stages of $9\frac{1}{2}$, $11\frac{1}{4}$, and $10\frac{1}{4}$ miles respectively.

The load of 15 tons useful and 5 tons carriages, or 20 tons in all, was to be transported by 2 horses one stage.

The expense of conveying one ton of goods the whole distance was proved to be about two shillings, or three farthings per ton per mile, and as the total quantity of tonnage passing between Liverpool and Manchester per diem, was estimated at 1200 tons, the expenses would be increased or diminished according to the traffic.

[We regret we cannot find space for the Estimate which accompanies this lengthy document.—ED. ARTIZAN.]

C. G.—The following is the list of the diagrams of curious modes of marine Propulsion exhibited at the *conversazione* of the Society of Arts, April 24, 1858. and which were explained at the Meeting of the British Association, in 1859, and some of them were described in a Paper read (April 1) at the Society of Arts, on "The Paddle-wheel and Screw-propeller," by J. MacGregor. We may, at some future time, comply with your request by giving the illustrations to which you refer.

1. Inflated skins pictured on the Nineveh marbles.
2. Swimming with the help of ice (A.D. 1472).
3. Chinese floating on skins (600 years ago).
4. Chinese rope for helping swimmers to cross rivers.
5. Skins used by Julius Cæsar (Seutonius).

5 (*a*). Egyptian raft of bulrushes.

6. Tartar raft tied to a horse's tail as a man swims by his side.
7. Chinese skin boat propelled by the hand paddling in the water.
8. Mandan Indian boat rowed by a woman with a spade-shaped paddle—the type of the British coracle.
9. German oar, like a mud-rake.
10. Japanese double paddle.
11. Greenlander's double paddle.
12. Egyptian two-oared reed boat.

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* Let V = maximum velocity of a horse unloaded
P V = power of a horse

then $$mv - \frac{mv^2}{V} = mv\left(\frac{V-v}{V} = Pv\right)$$

and $$m\frac{V-v}{V} = P$$

$\therefore \frac{1}{2} m$ or $\frac{250}{2}$ lbs. = 125 lbs. = P, or 125 lbs. × 3 miles × 6 hours = 2250 lbs. raised one mile.

At the Fenton Colliery one horse draws at the rate of 14 tons in 4 waggons per diem.

At the Barrington Main one horse draws at the rate of 16 tons in 4 waggons per diem.

At Fawdor Colliery (Mr. B. Thompson) one horse draws at the rate of 15 tons in 5 waggons per diem.

In the latter case one horse transports 15 tons $11\frac{1}{2}$ miles forward loaded, $4\frac{1}{3}$ tons $11\frac{1}{2}$ miles backwards empty, or 2208 tons transported one mile; total 23 miles.

According to Mr. Rennie's experiments, on the Grand Junction Canal, an ordinary horse was found to pull with an inconstant force of from 87 lbs. to 112 lbs., a barge weighing 27 tons, at the rate of $2\frac{3}{4}$ miles per hour for 18 miles, then calling the average traction 100 lbs.:—27 tons or lbs. $\frac{60480}{100}$ = 1 in 604, being considerably less than three times the resistance on a canal than on a railway at the same rate.

13. Ancient Egyptian mode of propulsion (the only one disused), in which men face the boat's side, and each holds two oars.
14. Common mode of rowing in ancient Egypt.
15. Two rowers facing each other (Nineveh marbles).
16, 17, 18. Egyptians sitting at the oar.
19. Unique drawing of ancient Egyptian rowlock.
20. Egyptian oar-slings.
21. Babylonian oars, bent and tied with a cross-piece.
22. One of the caravels of Columbus carrying oars (from a unique copy of the black letter edition, 1492, British Museum).
23. Boat drawn in shallow water by a plough.
23 (*a*). Modern canal boat on the Cam, drawn by a horse in the river.
24. An ox attached to oars in Ancient Egypt.
25. Boat propelled by water rising in sponge so as to turn a wheel.—(Congreve, 1853).
26. Paddle-wheel described in Vitruvius (1500 years ago), for telling a vessel's speed by dropping stones at intervals upon a bell.
27. Chinese vessel, propelled by fourpaddle-wheels, probably 600 yrs ago.
28. (*a*) (*b*). A chariot wheel on an Egyptian boat, and a Baylonian boat (mistaken for a paddle-wheel).
29. Paddle-wheels (R. Valturius, 1472) turned by oxen.
29. (*a*). Jonathan Hull's steamboat, and Papin's steam engine.
b. The Comte de Jouffroy's steamboat.
c. The "Thames," which steamed from Glasgow to London in 1815. Bellford's drum vessel, carrying the machinery and cargo inside, and rotating as it goes through the water.
d. Modern Chinese drawing of an English steam gun-boat.
30. Duquet's oblique vanes for winding up a rope.
30 (*a*). Bernouilli's screw steamboat (1752).
b. Australian fly, with screw propeller tail.
c. Plans of Watt, Miller, Shorter, and Fulton.
d. Dallery's screw steamer (1803).
31. Borelli's webbed fins and hooks, to enable a diver to swim like a frog and creep like a crab (1683). The air-bag round the head has a glass window, and the diver rises or sinks by an air cylinder, actuated like the natatory organ of a fish.
32. Borelli's "navis urinatoria," or "bladder like" submarine vessel, raised by expelling water from skins.
33. Williams' submarine vessel, with sleeves for the hands of men inside
34. The Nautilus machine. (1693).
35, 39. Steering apparatus in Egypt and Nineveh.
40. A tiller used in Ancient Greece.
41. Rudder from an old Japanese painting.
42. Steering by the branch of a tree on the Rhine.
45. Noah's Ark (from the Catacombs of Rome).
46. Ancient Persian Sculpture, representing a music-boat and oar.
47. An ancient vessel carrying fire-arms.
48 (*a*). Nile boat sketched by an Egyytian.
48 (*b*). The "heaven-bound ship" the Church (from the Catacombs.)
49. Chinese drawing of an English steamer.
50. The Leviathan.
51. Scott Russell's disconnecting apparatus—(*a*) the modification used for the paddle-shaft of the *Leviathan.*
52. Essex's hinged paddle-wheel. Drake's fan folding wheel. Galloway's additional paddle-wheel on an inclined shaft.
53. Galloway's divided floats, which slide together for reefing. Brunet's reefing float, clamped to an arm by a lever. Leeming's floats, protruded during part of each revolution by an excentric.
54. Silvester's feathering floats, worked by spindles and pinions. Lambert's feathering paddles, kept vertical by a heavy ring.
55. Oldham's floats, feathered so as to point to the top of the wheel. Feathering paddles of Lagergren, kept vertical by supporting the diagonal corners on wheels at different elevations.
56. Duncan's floating cylinder, carrying a spiral rib, which causes it to move forward as the cylinder is turned on its axis. Bucholz's method of gearing three propellers to steer by. James's propeller, turned by water discharged through openings at the ends of the blades (hollow).
57. The "Bommerang propeller" (revolving about the centre of gravity of the curved blade). Burch's propeller vanes round a plate revolving in a water-tight chamber across the vessel. Paterson's mode of producing a similar effect by using a conical drum fitted to the end of the vessel, cut off by a vertical plane.
58. The Paramecium (Infusorial insect) which propels itself by means similar to the paddle-wheel and screw-propeller combined. (The insect itself was shown to the meeting by one of Mr. Tomkins's microscopes.)

There was also exhibited one of Page's patent logs, made in 1770, and still in order (a screw, turned by the water, works wheels and pointers on dials); an original drawing, in 1788, (by Mr. Alexander Nasmyth) of the lake at Dalwinton, with Mr. Miller's steam-vessel upon it; sketch of the actual engine used in the boat (now in Mr. Woodcroft's possession); models of the inventions of Griffiths, Woodcroft, Tombs, Maudslay, Hunt, &c.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least—less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Wheatstone and the Universal Private Telegraph Company *v.* Wilde.—This case, which was partly heard before Mr. Baron Wilde and a special jury, and afterwards referred for arbitration to Mr. Lush, Q.C., after a protracted hearing of twelve days, has terminated in favour of the defendant. The plaintiffs' invention, upon which the action was brought, was for an improvement in the transmitting instrument of a magneto-electric dial telegraph, which consisted of a method of keeping the armature of the magneto-electric machine in continuous motion, while finger keys regulated the passage of currents into the telegraphic circuit. The defendant, by the peculiar construction of his magneto-electric machine, was enabled to stop the armature every time a finger key depressed. The armature was made to revolve by means of a pulley driven by a band, the tension of which was so regulated that, when the mechanism of the transmitting instrument (including the armature) was stopped by the depression of a finger key, the band slipped upon the pulley, and no more currents were produced; but, on releasing the finger key, the motion was immediately taken up, and currents were again generated and allowed to pass into the circuit. The plaintiffs contended that continuous motion of the motive power was equivalent to a continuous motion of the armature. It was, however, clearly shown that this was not so, for the defendant's armature required to be made very light, so that it might be stopped with facility; while on the other hand, the plaintiffs' armature being kept in continuous motion, its size and weight were of no consequence. The arbitrator, therefore, decided that a stopping armature could be no infringement of an armature in continuous motion, and that the bill of complaint in the Court of Chancery should be dismissed and the costs thereof, and of the reference and award, should be paid by the plaintiffs.

Fortifications of Portsmouth.—An important case was recently tried in the Sheriffs' Court of Hampshire, a special jury having been empanelled at Portsea for the purpose of assessing the compensation to be paid to Thomas Thistlethwayte, Esq., the Government having taken part of his estate, consisting of Portsdown-hill, which is four miles in length, and comprises 1000 acres, for the purpose of constructing the immense fortifications for the defence of Portsmouth on the land side; they also require the clearance of 1000 acres of the adjoining land from all hedges, ditches, trees, and other obstructions. Eleven surveyors were examined in support of the claim, whose average valuations amounted to £104,000. The case concluded in a verdict for the claimant of £95,200.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts (for which we are chiefly indebted to the *Chemical News*), Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

A New Trigonometer.—Mr. Josiah Lyman, of Lennox, Massachusetts, has invented a new trigometer. It is said to consist in a combination of the protractor, straight edge, and scale of equal parts. It is to be used in connection with a draughting board which has its sides adjustable. The long side of the semicircular protractor being placed against the edge of the draughting board, the steel ruler may be turned to make any required angle with the edge of the board. The angles are read by a vernier to minutes. A tangent screw and clamp afford facilities for small movements. Upon the ruler slides a scale plate plate for measuring distances, or for laying them down. There are six scales, representing divisions of 1 inch into 8, 10, 12, 16, 20, and 24 parts. Each has a vernier to tenths, and on most of them smaller parts may be estimated. The edges of the two parts of the sliding rule come down over the edge of the ruler to the surface of the paper, and five marks on these edges make it easy to lay down accurately on the paper the distances indicated on the scales and verniers. It is said that this instrument affords the means of plotting angles and distances with great accuracy and despatch. The aim has been to make it possible to lay down angles to minutes, and distances to thousandths of an inch. One great advantage of the instrument is that it facilitates the computation of areas in land surveying. When the corners of a field have been plotted, the differences of latitude and the meridian distances can be measured, in a very short time, with an accuracy far greater than that ordinarily used in the field-work of a survey. Great pains have evidently been taken to make the instrument accurate.

MANUFACTURE OF COKE, AND ECONOMY OF FUEL.—An invention has been provisionally specified by Mr. John Halford, of Great Barr, which relates to improvements in collecting and utilising smoke, gases, and such like products of combustion, rendering the same available as a source of heat, which improvements are also applicable to the desulphurisation of coke. In applying the invention to coke ovens, or open coke heaps, he constructs, instead of the chimney now in use, a close built or solid chimney, closed at the top, but with a circle of holes near the top. This solid chimney is enclosed in another of the same kind as that ordinarily in use, or one so constructed as to draw off the smoke. The outer chimney is connected with the inner one or not, according to circumstances. The products of combustion are conveyed to a pipe or flue at the bottom of the fire, and thence to the place where the heat is to be applied; they are conveyed, or instance, under a boiler, and, being there ignited, the heat produced serves either partially or totally instead of ordinary fuel. He remarks that from the increased draught caused by this means of burning coal into coke, the sulphur is more effectually extracted from the coke than by the ordinary method.

NEW SYSTEM OF WEIGHTS AND MEASURES.—In a parliamentary blue-book, lately issued, some suggestions are made by the select committee appointed to inquire into weights and measures, as to the introduction into this country of the French metric system, which is based on the decimal principle of calculation. The committee recommend that only the metric and imperial system should be continued, and that the Board of Trade should take the management of the matter, predicating that such an adoption would lead to the use of the decimal coinage in the United Kingdom.

MANUFACTURE OF COKE.—Mr. T. Ramsey, of Newcastle-upon-Tyne, has invented some improvements in the manufacture of coke. The usual custom is to employ small coals, which pass through a half-inch screen or riddle; and various patents have been granted for crushing large coal, to be used for the manufacture of coke in conjunction with tar, lime, and other materials, but this plan consists in reducing large or the small coal described above to the finest state of powder, before converting it into coke. The patentee prefers to employ rich bituminous or coking coal, which he grinds under edge stones, horizontal stones, or rollers, to a powder almost as fine as flour. Horizontal stones similar to those used in grinding flour are found to answer best, as all other forms of grinding machinery necessitates the use of riddles or sieves to remove the small pieces which escape the action of the machinery. This finely ground coal is then put into the coke ovens, and burnt in the ordinary manner, with the usual precautions. The coke obtained is much more dense and hard than that obtained by any of the other processes, and leaves, before being sent away, a smaller quantity of broken pieces, known in the trade under the name of breeze. These small pieces are reduced to the same state of powder as the coal, and mixed therewith when necessary, the mixture being converted into large coke in the ordinary coke ovens. Although bituminous coal is preferred to be used, the plan is equally applicable to semi-bituminous coal, or coals known as steam, gas, or house coal. Those coals which do not cake, or only imperfectly, such as anthracite, can be converted into superior coke when reduced to this fine degree of powder, and mixed with equally fine bituminous coals, in proportions varying with the character of the coal. Any form of coke oven, long, square, or round, and of any shape, may be employed in using this finely divided coal.

NEW EXPLOSIVE COMPOUND.—A new explosive powder, invented by Mr. Reynaud de Tret, appears destined to render great services to the working of mines in consequence of its low cost price. It is stated to be particularly applicable to the working of stone quarries. It is composed as follows:—Nitrate of soda, 52·5; residue of tan (after having been used in the tanning of hides), 27·5; pounded sulphur, 20·0; total, 100·0.

SELF-WEIGHING CARTS AND TEAMS.—A simple and ingenious self-weighing cart, designated the "Voiture-bascule," has been patented in this country and on the continent, by Messrs. Debreuil and Co. The object of the invention is to enable a load, or any part thereof, of any material whatever, to be weighed without removal from the carriage in which it may happen to be, and at any place where it may happen to be received or delivered, thus ensuring the greatest possible satisfaction both to buyer and seller. The "Voiture-bascule" is a combination, in fact, of an ordinary cart and a steel-yard weighing machine, in such a manner that except when actually employed in weighing, the cart is as firm and immovable as though no weighing apparatus were attached. The improved cart consists of a strong frame, mounted on the wheels in the usual manner, the body being made entirely separate. The steel-yard is fixed in the centre of one side of the frame, the short arm being connected by a rod with the end of a lever passing in the same direction as the axle of the wheel, and the opposite end of which is keyed to the fulcrum which is attached to the other side of the frame. Between this fulcrum and the rod attached to the steel-yard there is a saddle connected with the apices of two triangles, the bases of which are at each end of the frame, and are supported on knife edges of hardened steel. While the cart is in use for ordinary purposes the body is bolted to the frame, and the weighing machine is altogether independent and out of use; but when it is desired to ascertain the weight of the contents of the cart, all that is necessary is to remove the bolts, and turn four screws, in order to elevate the knife edges, which carry the bases of the triangle about half-an-inch. Now, as this elevation causes the cart-body to be lifted upon other knife-edges upon the upper side (also at the bases) of the triangles, it follows that the weight of the cart will be thrown on the short arm of the steel-yard, when the load may be weighed in the usual manner. Although our description is thus long, the arrangement is by no means complicated, nor are any of the parts more likely to get out of order than an ordinary weighing-machine, and the apparatus can be manipulated with such facility that the withdrawal of the bolts, the rising of the cart-body, the weighing of the load, and the reinstating of the cart ready for traction does not occupy two minutes. There are doubtless a vast number of purposes to which the invention could be most advantageously applied.

THE REPORT OF THE COMMISSIONERS OF PATENTS for the year 1861 states that the number of applications for provisional protection recorded in the year 1861 was 3276; the number of patents passed thereon was 2047; the number of specifications filed in pursuance thereof was 2015; the number of applications lapsed or forfeited, the applicants having neglected to proceed for their patents within the six months of provisional protection, was 1129. The Act 16 Vict., c. 5, enacts that all letters patent for inventions to be granted under the provisions of the Patent Law Amendment Act, 1852, shall be made subject to the condition that the same shall be void at the expiration of three years and seven years respectively from the date thereof, unless there be paid, before the expiration of the said three years and seven years respectively, the stamp duties in the schedule thereunto annexed, viz., £50 at the expiration of the third year, and £100 at the expiration of the seventh year. The patent is granted for 14 years. Four thousand patents bear date between the 1st of October, 1852, and the 17th of June, 1854 (being the first 4000 passed under the provisions of the Patent Law Amendment Act, 1852). The additional progressive stamp duty of £50 was paid, at the end of the third year, on 1186 of that number, and 2814 became void. The additional progressive stamp duty of £100 was paid at the end of the seventh year on 690 of the 1183 patents remaining in force at the end of the third year, and 796 became void. Consequently nearly 70 per cent. of the 4000 patents became void at the end of the third year, and nearly 90 per cent. became void at the end of the seventh year. The number of patents sealed in 1854 was 1876; the progressive duty of £50 due in 1858 was paid upon 558 of this number; and the progressive duty of £100 due in 1861 was paid upon 142 only; therefore the proportionate number of patents becoming void by reason of non-payment is increasing. All the provisional, complete, and final specifications filed in the office upon the patents granted under the Act since 1852, have been printed and published in continuation, with lithographic outline copies or the drawings accompanying the same, according to the provisions of the Act 16 and 17 Vict., c. 115. The provisional specifications filed in the office and lapsed and forfeited have also been printed and published in continuation. Printed certified copies of the specifications filed in the office, as also certified copies of patents, and of the Record Book of Assignments of Patents and Licences, with copies of such assignments and licenses, have been sent, in continuation, to the office of the Director of Chancery in Edinburgh, and the Enrolment Office of the Court of Chancery in Dublin, pursuant to the Act of 1852 and the Act of 16 and 17 Vict., c. 115. The work of printing the specifications of patents under the old law, 13,561 in number, and dating from 1711 to 1852, was completed in 1858, and copies thereof are sold in the office at the cost of printing and paper.

STEATITE, OR SOAPSTONE.—Mr. Barrow Moss, of Liverpool, has provisionally specified an invention, according to which he proposes to employ steatite, or soapstone, which is a silicate of magnesia, as a substitute for fire-clay, over which it possesses many important advantages. The steatite is reduced to powder, and moistened with a weak solution of potash to make it bind; it is then shaped or formed by compression into moulds by hydraulic pressure, or otherwise, and baked or burned in the usual manner.

PICKIN'S CARRIAGE BODIES.—Messrs. Pickin, of Birmingham, have just specified a patent metal carriage body, having for its object the combining of strength with lightness. According to this invention a bar or rod of metal is bent into the required shape for the seat, and welded or otherwise joined at the ends, and a second bar or rod is bent into the form intended for the back, and its ends joined to the seat, bar, or rod. Transverse wires or rods are fastened across the seat frame, and one or more are fastened midway of the back frame. The skeleton frame thus formed is completed by the addition of a number of curved wires of an ornamental configuration following the sweep of the back, and decorated with woven wirework and wire scrolls. It is recommended that the whole should be galvanised, and the wires are secured by the galvanising and by binding wire. More strengthening pieces may be added if desired.

GOLD SILVER, AND COPPER COINAGE—From a parliamentary return just issued, it appears that from 1852 to 1861 inclusive, there were 13,453,839,860 ounces of gold coined at the Royal-mint into 52,385,860 sovereigns, and 1,897,125,987 ounces of gold into half-sovereigns. In the same period there were coined 16,471,352 florins, 23,937,475 shillings, 20,047,996 sixpences, 16,430,756 threepences, 1,849,574 groats, 41,540 fourpences. 16,430,756 threepences, 59,412,864 pennypieces, 89,642,781 halfpence, and 20,122,516 farthings.

PARIS UNIVERSAL AND PERMANENT EXHIBITION.—This building, which is now in progress, is situated at Auteuil, close to the road and railway, and just within the ramparts. The enterprise is undertaken by a company. The estimated cost of the building is £600,000, the whole of which has been subscribed in France. The object is to found a place of resort for producers, dealers, and customers from all parts of the world, where commodities may be compared and purchased under one roof. The shareholders are to be reimbursed by the rentals charged to exhibitors, and the public will be admitted free on the last five days of the week. The main building will consist of an open nave, running north and south, presenting a clear and uninterrupted space of 1050ft. long, 130ft. wide, and 110ft. to the crown of the semicircular roof, which springs at a height of 35ft. from the floor line. This nave will be intersected by a transept of equal width and height, 550ft. in length, above which a dome will rise to a total height of 345ft. The domes at the London International Exhibition building are 250ft. in height. On each side of the nave there will be aisles 100ft. in width, and again on the west side, two supplementary aisles of equal width but of varied length, planned in accordance with the site. Over all these aisles, at a height of 25ft. from the ground, galleries will be constructed. The total length of the building externally will be 1315ft. A machinery annexe, 600ft. long, and 100ft. wide, will occupy the north east corner of the ground. The architect is Mr. Liandier; the contractor Mr. Edwards, and the iron castings are being made by Messrs. T. Eddington and Son, of Glasgow.

DUNLOP'S CALCULATOR.—This invention is intended to supply a desideratum which has long been needed; by its use fractional calculation, which hitherto has been difficult and tedious, is made clear, and a child with half an hour's study of the explanation can master it with ease and accuracy. It is a combination of the slide rule and the ready reckoner. Multiplication of money by quantities from $\frac{1}{32}$ of an unit to nearly 100,000 in any combination of figures, at prices varying from $\frac{1}{32}$ of a penny upwards, advancing by 16ths and 8ths to pence and shillings in any combination of prices, are readily and accurately computed. Division of money, for obtaining the value of the unit or costs, are also worked by it, and to the same extent of figures as in multiplication. It weighs less than 2oz., and is alike suitable for the desk and the pocket.

NEW SOUTH WALES COAL.—It has already been stated that the Peninsular and Oriental Steam Navigation Company had accepted the Australian Agricultural Company's tender for the supply of 10,000 tons of coal, and we now learn that the Lords of the Admiralty have sent out orders that New South Wales coal shall be used in her Majesty's ships on the Pacific and Australian stations. The virtual admission of the excellent quality of this coal is due to the results of the experiments recently conducted at Woolwich Dockyard. The Australian Agricultural Company's "get" of coal for the year 1861 was 92,570 tons, at a cost of £43,598 19s. 3d.; and, as it realised £59,737 10s. 1d., a profit is shown of £16,138 14s. 10d., being an average of 3s. 5¾d. per ton.

UTILISING THE WASTE HEAT OF FURNACES.—In the re-burning of animal charcoal in revolving retorts much heat has hitherto been wasted; for this Mr. P. Cowan (Cowan and Sons), of Barnes, proposes a remedy, having just patented an invention, the object of which is to utilise this lost heat. Under the invention which he has just patented, he proposes to apply to or combine with the furnace in which the retorts, vessels, or cylinders are fitted and heated, or to or with the flues communicating with such furnace, a boiler, or generator, in such position as to be exposed to the action of the waste heat of the furnace, so that if desired steam shall be generated in such boiler or generator simultaneously with the carrying on the process of re-burning the charcoal. The steam so produced may be carried off for use as required. The claim includes partially revolving chambers also.

IRON FORMED BY ANIMALCULES.—M. Oscar de Watteville announces the fact, not generally known, that in the lakes of Sweden there are vast layers or banks of iron, exclusively built up by animalcules, not unlike those that have laid the foundation of large islands in the ocean, by silently and for ages cementing matter with matter, so as to create those beautiful forms known as madreporæ, milleporæ, corals, &c. The iron thus found is called in Sweden lake ore, distinguished, according to its form, into gunpowder, pearl, money, or cake ore. These iron banks are from 10 to 200 metres in length, from 5 to 15 broad, and from a fourth to three-fourths of a metre in thickness. In winter, the Swedish peasant makes holes in the ice of a lake, and, with a long pole, probes the bottom until he has found an iron bank. An iron sieve is then let down, and, with a sort of ladle, the loose ore is shovelled into the sieve, which is then hoisted up again. The ore thus extracted is mixed with a quantity of sand and other extraneous matter, which is got rid of by washing in a cradle, similar to that used by gold diggers.

NAVAL ENGINEERING.

Naval Appointments.—The following have been made since our last: A. Long, in the *Trafalgar*, J. Cooper, in the *Pembroke*, and W. Nicholson, in the *Ajax*, promoted to First-class Assist. Engineers; J. Rogers, in the *Melpomene*, A. H. Rogers, in the *Neptune*, T. S. Grier, in the *Amphion*, W. N. Brinefield, in the *London*, and H. Onions, in the *Imperieuse*, to acting First-class Assist. Engineers; G. E. Foote and C. Thomson, Second-class Assist. Engineers to the *Terror* and *Cumberland* respectively; J. Sharp, in the *Fisgard*, confirmed as Second-class Assist. Engineer; T. Summers, Engineer, to remain additional to the *Asia*; J. Rice and A. Smith, First-class Assist. Engineers, and G. Edwards, acting Second-class Engineer to the *Asia* for the *Psyche*; W. W. Webber, First-class Assist. Engineer, to the *Asia*, for the *Swinger*; A. Gillies, Engineer, to the *Dasher*; A. Wood, First-class Assist. Engineer, and A. Wilson, Second-class Assist. Engineer, to the *Severn*, for transfer to *Pantaloon*, when commissioned; A. Moreton, Second-class Engineer, to *Indus*, as supernumary; H. Clark, in the *Cumberland*, for the *Cochin*; and J. L. Davis, in the *Sphinx*, confirmed as First-class Assist. Engineers; J. Flintoff, in the *Coromandel*, P. Robertson, in the *Edgar*, A. Moreton, in the *Indus*, confirmed as Second-class Assist. Engineers; P. Blanch, Second-class Assist. Engineer, to the *Cumberland*, as supernumerary; J. Stephens, acting Second-class Assist. Engineer, to the *Rosario*; F. S. Turner, and W. J. Fellowes, acting Second-class Assist. Engineers, to the *Indus*, as supernumeraries; J. Moreton, in the *Indus*, for the *Tilbury*, confirmed as First-class Assist. Engineer; H. Rumble, in the *Fisgard*, and J. Fawcett, in the *Rattlesnake*, confirmed as First-class Assist. Engineers; Joseph Sharp and W. Ball, Second-class Assist. Engineers, and R. Roberts, acting Second-class Assist. Engineer, to the *Cumberland*, as supernumeraries; J. Wood, in the *Spider*, J. Edmonds, in the *Satellite*, W. H. Haddow, in the *Swallow*, and W. R. B. Braving, in the *Ajax*, confirmed as Second-class Assist. Engineers; N. Rider and W. H. G. West, in the *Indus*, confirmed as Second-class Assist. Engineers; H. Loudon, acting Second-class Assist. Engineer, to the *Indus*, as supernumerary; J. F. Hughes and W. Ambler, acting Second-class Assist. Engineers, to the *Cumberland*, as supernumeraries; T. R. Butters and J. Eelder, acting Second-class Assist. Engineer, to the *Asia*, as supernumeraries; J. W. Watson and G. B. Blackwell, confirmed as Second-class Assist. Engineers; T. B. Jordan and J. T. Morgan, acting Second-class Assist. Engineers, to the *Asia*, as supernumeraries; G. A Luck, Chief Engineer, to the *Cumberland*, for the *Royal Oak*; B. Foreman, Engineer, confirmed in rank; J. C. Robinson, Chief Engineer; W. Crosbie, Engineer; T. Edgar, First-class Assist. Engineer; and C. F. Gregory, H. Ryder, and E. Hocken, Second-class Assist. Engineers, to the *Phœbe*; A. Gillies, Engineer, to the *Sprightly*; D. McFarlane, Engineer, to the *Severn*; T. B. Martin, Acting Engineer to the *Dasher*; A. B. Gutteridge and F. Earnshaw, acting Second-class Assist. Engineers, to the *Asia*, as supernumeraries; S. H. Trenham and J. Lewthwaite, acting Second-class Assist. Engineers, to the *Cumberland*, as supernumeraries; J. Roffey, Chief Engineer; J. Sumner, Engineer; R. H. Dobney, H. R. Wills, and T. Gray, First-class Assist. Engineers; A. S. Reeve, Second-class Assist. Engineer; and H. Rigby, acting Second-class Assist. Engineer, to the *Sutlej*; J. Orchard and D. Danglands, First-class Assist. Engineers, to the *Asia*, for the *Savage* and *Foam*, respectively; J. G. Taylor, First-class Assist. Engineer, to the *Phœbe*; G. W. Robins, First-class Assist. Engineer, to the *Indus*, for the *Delight*; R. W. Meiklejohn, in the *Euryalus*, promoted to First-class Assist. Engineer; C. Laurence, Second-class Assist. Engineer, to the *Defence*.

A New Method of Preparing Iron Plates for ships' sides which it is expected will very much facilitate that difficult work, has lately been invented by Mr. Mattison, an artizan in the Devonport dockyard. It is thus described:—The first process, taking the mould for the curve of the plate, is effected by what is termed an "ordnance-box," that is a wide piece of iron standing on its edge through which a number of moveable bolts are placed. On the points of the bolts being fitted against the side of the ship, they are pressed home into the hollows of the curve until the exact shape is obtained. They are then fastened by screws and thus rendered immoveable. In connection with taking the mould is another instrument for obtaining the levels and curved edges of the ships' side. It is made of polished iron, exceedingly flexible, so that it readily conforms itself to the curve, when, by movable pieces of iron crossways and lengthways, the levels are taken. The instrument, on being removed, returns immediately to its original flattened shape, the edges only retaining the peculiar form given to it by the ship's side. This instrument is for the levels only, the curve of the ship's side being obtained by the other. The mould being thus taken, is transferred to the machine that actually makes the curve, which consists of a kind of iron box, fitted with what are termed "peppots"—that is, a number of pieces of iron about an inch square and 10 inches long. These, by screws in the bottom, can also be lowered or raised, and the mould being placed on the top of these movable pieces of iron, the exact shape of the curve is secured, and the "peppots" are screwed into their proper position. Another framework, containing smaller pieces of iron in a converse position, is suspended over the one already described. When the plate to be curved has to be laid on, the lower framework is drawn out on a kind of rail; the plate, after being heated, is laid on the top of the "peppots," and drawn into its former position by means of a lever; the upper "peppots" are brought down with such power as to secure the required shape. The plan is said to possess great advantages over the one now in use for taking the curves by means of wooden moulds, which are usually 3½ft. wide, 4½ft. thick, and about 15ft. long. These moulds are cumbersome and costly. The model is 20in. wide, 30in. long, and 42in. high, and is to be sent to Woolwich to be tried.

New Propelling Power.—On the Scheldt, near Antwerp, experiments have been made with a new boat, provided with a new propelling power, which has been recently discovered. The boat has neither paddle-wheel or screw. In the middle of it, however, is a cone-shaped kettle into which the water is pumped up, and from which it is driven out with great force into the river through two curved boxes on the side of the boat, by which means the vessel is propelled forward with swiftness. By simple machinery the arrangements of the boxes can be so altered that the boat can be turned immediately and steered in any direction. The experiments made with this boat, which is intended to ply between Link and Seraing, have far exceeded expectation.

MILITARY ENGINEERING.

Important Artillery Experiments at Shoeburyness.—A series of experiments were tried on the 17th ult. before the Duke of Somerset. They have led to the most interesting and important results. The first experiments were with the monster wrought iron Horsfall gun. This gun was fired at a target representing the side of the *Warrior*. The charge was 75lbs. of powder and a 270lb. shot. The result was what everyone on the ground expected—the target was dashed to pieces. After the first shot, the experiment was considered so conclusive in favour of the gun, that it was not fired again. The second series of trials were made with the 12-pounder field gun and the 70-pounder naval gun, with the view of testing the penetration of Whitworth's flat-fronted hardened shells against armour-plates. All shells of whatever kind hitherto tried against armour-plates have failed to produce the least effect upon them. They have always broken like so many glass bottles, merely injuring the target with the flame of their explosion. So constant and invariable were these results, that it was taken as an established fact that vessels coated with 2½in. or even 2-in. armour-plates would suffice to keep out any shell. As it is only shell which is dreaded in naval warfare, the Danish, Prussian, and Russian Governments have each built gunboats covered with 2½in. armour, confident that this is ample to protect their crews against all but solid shot. For the first time Mr. Whitworth, on this occasion, proved the complete fallacy of this theory. The first trial was made with the 12-pounder, which sent its solid flat-fronted shot completely through an iron plate 2½in. thick—no slight result, when we consider the lightness of the projectile. The next trial was made with shell, fired from the same rifled 12-pounder, against a target of 2-inch armour plate, with a backing of oak beams nearly a foot in thickness. The shell, with a bursting charge of 1lb. 14oz. of powder, passed through both plate and backing, and buried itself in the earth beyond. The next, with a charge of 1lb. 11oz. of powder, also passed through the plate, but burst in and shattered the timber backing behind. This showed conclusively that the foreign gunboats which have been built with a 2½in. iron casing are vulnerable to Whitworth hardened projectiles, even when fired from as light a gun as his 12-pounder. This result, unexpected as it was, was surpassed by that obtained with the 70-pounder naval gun, when fired with shell against a stronger target. This target was constructed of armour-plates bolted upon an oak frame 9in. thick, attached by a side framing to a back of oak 4in. thick, coated over with 2-in. wrought iron. The interval between the front and back frames was between 2ft. and 3ft., the target being intended to represent the side of a ship. The shell weighed, when charged, 70lbs., and contained 2lb. 6oz. of powder. This, fired with a charge of only 12lbs. of powder at the usual penetration range of 200 yards, passed completely through the 4in. armour plate and oak backing, and burst inside the frame, shattering it to pieces. This result was obtained not by a gun of unusual weight or calibre, but with one weighing some 15cwt. less than the naval smooth bore 95cwt. gun, and with a charge of powder of only one-sixth the weight of the projectile. On the 25th ult., the experiments with the Whitworth gun were resumed on a larger and more important scale, with the following results:—The target aimed at on this occasion was, a built-up section representing the *Warrior's* side. It was not the original old *Warrior* target, which has been withdrawn from active service. It was a new target, specially made for these experiments, 21ft. long by 15ft. high, constructed on the same principle as the old one—namely, with 4½in. iron plates, 18in. of teak beams laid transversely, and an inner skin of iron ⅝in. thick, supported by massive upright angle irons, at intervals of 18in. apart. It is but fair, however, to state, that the 4½in. armour-plates which covered this powerful combination of teak and iron were not manufactured by the Thames Iron Company, and were, undoubtedly, inferior in powers of resistance to the splendid plate with which the first *Warrior* target was coated by that company. The first experimental shot was fired with a charge of 23lb. of powder and a solid hexagonal shot weighing 129lb., the piece being laid at half a degree of elevation. It struck the left centre of the target within an inch almost of the white spot at which it was aimed, and at the instant of the tremendous concussion of the metals a bright sheet of flame was emitted, almost as if a gun had been fired from the target in reply. The shot passed completely through the armour plate, shattering the teak beyond into minute splinters, and fell full upon one of the massive vertical angle lines which it tore in half as if it had been paper, sending its screw bolts and rivets in all directions. The shot, however, did not pass through the target, but remained buried in the teak with its flat head resting against the broken angle iron. But the fracture it made was much worse than a mere penetration. It was a smash, not a hole, and the inner skin of the ship was bulged and torn wide in many places, so that in the case of in actual vessel such a shot striking on the water line would have made a leak which nothing could have stopped. As regarded the effect of these flat-fronted shots on iron ships, the experiment was conclusive. The next experiment was with a live shell loaded with 3lb. 8oz. of powder. The total weight of this projectile was 131lb., and it was fired at the same range and elevation with a 25lb. charge of powder. The effect of this shot astounded every one. The previous solid shot, at 600 yards, was for Whitworth nothing very extraordinary, but to get a shell through the target at the same range was regarded as almost an impossibility. Yet the shell went completely through everything, bursting apparently when it encountered the last resistance of the inner skin, which the explosion blew completely away, lighting for a moment the timbers at the back which supported the target, and sending the bits of shell onward and over what, had it been the *Warrior*, would have been her maindeck, and therefore right in the midst of her crew. Than this experiment nothing could possibly have been more conclusive. Not only was the armour-plate pierced, but the piece opposed to the actual stroke of the flat-headed shell was driven through teak and inner lining, and, in truth, became another shot of some 30lb. weight. In fact, this last shell might have destroyed the whole of one side of the target had the shell been only capable of containing an adequate bursting charge—say 10lb. or 12lb. of powder. This experiment with the shell was, therefore, considered so far satisfactory as to its penetrating powers, that no further attempts were made with it, and the trials were continued with the Horsfall gun at 800 yards against the uninjured plates of the same target. The immense difference between the powers of a smooth bore and a rifled gun, both as to accuracy and force of its projectile, then at once became apparent. The first shot fired from the Horsfall with 74lb. of powder and a 275lb. round shot struck in front of and some 10 or 12ft. to the left of the target, which it missed altogether. The gun was relaid again, and again the shot struck the ground about 40ft. in front of the mark, ricochetting with a slight rise, and striking full on an uninjured plate. In this case it smashed an immense hole, shattered the teak, and fractured the inner skin, leaving all the elements of a fearful leak, as Mr. Whitworth's fire shot had done, but, like that also, not going quite through. The third shot again missed the target entirely, striking wide of the mark; and the fourth, and last, the extreme uppermost corner of the target, the metal of which it smashed. The failure of this gun at this range was therefore as satisfactorily settled as the success of Mr. Whitworth's, and the trials were discontinued. The trial test was then made at 200 yards with the old smooth-bore 68-pounder, and the depth of the indent made by this projectile showed at once that the plates were by no means equal in resisting power to those which covered the old *Warrior* target. The metal was exceedingly brittle.

Iron Plate Experiments at Portsmouth.—Some interesting experimental firing has taken place at Portsmouth since our last, with wrought and cast-iron shot and 8in. shells from the 95cwt. smooth-bore gun of the *Stork* gunboat. One day's experiment consisted of the testing of a cellular target built on a plan proposed by Captain Hewlett. The front and back plates of this target were composed of 1⅝in. plate, separated by ⅝in. ribs, 15in. in depth, to which were attached the front and back plates of the target by ⅝in. angle irons, 4in. by 4in. These ribs were placed vertically, and in six feet of the target's length were eight inches apart only, in the remaining six feet being 18in. apart. The interior of the target was thus composed of a series of cells or flues, in one half of the target measuring 8in. in breadth, 15in. in depth, and 8ft. in length. In the remaining half of the target they measured the same length and depth, but were 18in. in breadth. The whole structure was 12ft. in length, 8ft. in breadth, and 15in. in depth (internally). It was fastened by the ordinary form of bolt, with nut and screw, from the inner plate only to the ship's sides. This slight structure was not expected to arrest the progress of the 68lb. solid shot, with a velocity through the air of 2000ft. per second; but comparative results only were sought, as a guide to the minimum thickness of plate required to so crush the 68lb. cast-iron shot in its passage through an armour plate that it should afterwards be powerless to inflict any material injury upon any substance within a certain distance of the plate's reverse side. The two plates selected for the experiment had each been previously fired at several times on the day they were officially tested, according to the usual mode, the 95cwt. gun, at 200 yards' distance, throwing a 68lb. cast-iron shot, with a charge of 16lb. of powder. In the experiment referred to the gunboat was moored at a distance of 50 yards only, in lieu of the ordinary practice range of 200. The gun used was the *Stork's* 95cwt. smooth bore, with wrought iron shot in both instances. The Thames Iron Works Company's plate of hammered iron was first selected for trial, and the wrought iron shot was sent against its least damaged part with a charge of 22lb. of powder. The shot buried itself two-thirds of its diameter in the plate, but the latter had no cracks whatever extending beyond the immediate fracture caused by the penetration of the shot—about 9in., or exceeding the shot's diameter by one inch. The second shot, also of wrought iron, was directed against the least damaged part of a rolled plate, manufactured by Messrs. Brown, of Sheffield, with a charge of 25lb. of powder, 3lb. additional to the last experiment. The shot in this instance embedded itself in the plate about three-fourths of its diameter, the plate also in this instance remaining remarkably free from radiating fissures or cracks. No plates have ever been before submitted at Portsmouth to so severe a test, and none had as yet so successfully resisted the impact of shot as these two had done. Still these plates must not by any means be taken as representing the ordinary quality of our ships' iron armour. The *Java* target ship, lying in Portsmouth harbour, has now a number of armour plates on her sides which have been tested in the usual manner with the 68lb. cast-iron shot, propelled by 16lb. of powder, at a distance of 200 yards, and the difference in the effects produced by the shot upon the various plates is astonishing. Upon some the shot has made an indent, impressed its "mark" as though upon a piece of soft baker's dough, of an inch or an inch-and-a-quarter at its greatest depth, and this has been the extent of the mischief. Not a crack is observable, nor is there a bolt started. The good metal in this instance has faithfully performed its duty. It has allowed the would-be-intrusive shot to leave its mark behind, but the shot's further progress has been stopped, and it has been hurled backwards in a hundred broken splinters, and this without the slightest injury to the plates' "backing" or frame of the ship. Other plates, again, have broken up like sheets of glass beneath the blows of the shot, and driven into the ship's side by each successive shot, have shattered the timbers and planking into matchwood, and have been turned into an active agent in the destruction of the ship they were intended to protect. The inference to be drawn from an inspection of the *Java's* side and her tested armour plates would appear to be this:—If plates of iron can be manufactured of sufficient strength and tenacity to resist the penetration of shot, wrought or cast, from the 95cwt. smooth-bore gun at close quarters, it must be an immense advantage and protection to the crew to have their ship so clothed with defensive armour. But, on the contrary, to clothe a ship with such brittle material for armour as may be now seen driven into the sides of the *Java* would be merely to ensure the ship's destruction the first time she came under fire, when she would in all probability speedily go down from the effects of leaks caused by her broken armour plates.

Some firing at armour plates manufactured by Government and by a private firm took place at Portsmouth, on the 11th ult., of a very interesting and important nature. The plates comprised three forged at Deptford Dockyard, each 12ft. in length, 15in. in width, and 4½in. thick, the whole weighing 71cwt. 1 qr.7lb. Of four forged at Portsmouth dockyard, one was made from scrap iron, unannealed, 7ft. 11⅝in. in length, 3ft. 6½in. in width, and full 5½in. thick, weighing 54cwt. 3qr. 14lb. The second plate was also made from scrap iron, but was annealed. It was 8ft. in length, 3ft. 5⅞in. in width, and full 5½in. thick; its weight was 56cwt. The third plate was made of Shropshire puddled iron, unannealed, was 8ft. in length, 3ft. 7in. in width, 5½ (full) thick, and weighed 55cwt. 3qr. The fourth was also made from Shropshire puddle, but was annealed, was 8ft. in length, 3ft. 7⅞in. in width, and 5½in. thick, and weighed 56cwt. 2qr. 7lb. The remaining plate was manufactured by Messrs. J. Brown and Co., at the Sheffield Atlas Iron and Steel Works, and had been selected from a heap of plates at the works, which had been manufactured by them for the *Royal Sovereign* shield ship, by Mr. Luke, the Government surveyor, and forwarded to Portsmouth for testing in accordance with the Government regulations under which the contracts are entered into with private manufacturers. Its dimensions were—length. 14ft. 11⅝in.; width 3ft. 3in.; thickness, 5⅜in.; weight 94cwt. 3qr. The whole of the plates had been secured to the side of the *Alfred* target ship, which was afterwards taken up to the practice moorings in Porchester-creek, where the practice took place, from the 95cwt. gun of the *Stork* gunboat, under the superintendence of Captain Hewlett, C.B. Solid 68lb. shot were thrown with the ordinary 16lb. of powder. Unusual interest was attached to the trial, owing to the plates from the Government yards having been manufactured expressly to test the actual cost of manufacture as a contrast to the price now paid to contractors, and also to decide upon the respective merits of puddled and scrap iron for their manufacture, and of the process of annealing. The presence of Messrs. Brown's plate was a chance, but being there for testing, it offered a means of representing the interests of our large iron workers on this, to them, most important occasion. The result of the day's firing ended in the destruction of the plates made in the Government yards, which broke up under the blows of the 68lb. shot in an extraordinary manner, and in the success of Messrs. Brown's *Royal Sovereign* plate, after passing through an ordeal severer in its nature than any to which a plate had at any previous time been subjected at Portsmouth. The failure of the plates forged at Portsmouth yard is ascribed to the sulphurous nature of the coal with which they were forged, and an inspection of the broken parts left no doubt of this being the fact. Attributing the failure of the plates to the sulphurous nature of the coal does not speak much for the storekeeper or other Government officers who selected the coal, and would be deemed by any private firm a curious excuse to make for failure of iron plates. The Deptford Dockyard plates owed their failure—leaving out of the question their quality—to their being only 15in. in width, and being, in fact, iron planking. This kind of plating has been before tested at Portsmouth, but it can never, in such narrow strips, stand the blows of a solid shot. The first shot the plates received struck the middle strip, buckled up the end, and broke the bar clear through about 12in. from the point of impact. Another shot struck the broken part, and, crushing itself, carried its own and the plate's broken portions through the frigate's side, on to the main deck. The remaining two shots at these plates proved the utter uselessness of their form. Of the four plates manufactured at Portsmouth, the annealed in both the scrap and puddled may be considered to have been the best, but the fissures caused by each blow of the shot were so extensive and their appearance at the close of such a nature that no deductions can be drawn from the results in their case with any certainty of their value. Messrs. Brown's plate received nine shots. The first struck the centre to the left, made an indent at its deepest part of 1 8-10in., 8½in. in diameter, and 9in. from a bolt-hole. No cracks or bulging. The second shot struck 12in. to the right of the first, impressed a mark 9in. in diameter and an indent of 1 7-10in., 7in. from a bolt-hole, and no cracks or bulging. The next shot struck an equal distance to the left of the first shot, all three now being in line, with an indent of 2in. and a diameter of 9in. no bulging or crack. The next shot struck with two-thirds of its circumference on the first shot mark, and spread the metal, increasing the depth of the indent to 3in., but still with no sign of a crack or separation of the fibre of the metal. The remaining five shots were fired in succession at the plate without waiting to inspect the result of each, as is usually the case, as the plate had now stood its test in so extraordinary a manner that it was determined to give it as severe a trial as possible. At the close of the firing on inspecting the plate it was found that seven shots had been placed in a crescent form, the length of the semi-circle, measuring through the line of shots, being 4ft., and four of these shots having struck in a space of 20in. by 12in. Only on this spot was there any sign of a crack, and here it was caused purely by the severe pounding stretching the metal, and even this was of a very slight character. This continual strain upon one part of the plate caused the left hand of it to bulge outwards a little, and raised a slight crack at the back of the lower shot mark. The plate remained perfectly invulnerable at the close of the firing, and on a ship's side would be fit to go into action with her again, its protective power being but little injured. It is the first armour plate that has received, in any of the long series of experimental practice at Portsmouth, seven shots in the same amount of space, and, being a plate selected from a heap of others by the Government contractor, its successful resistance to the 68-pound shot in the trial, under such severe circumstances, reflects the greatest credit upon its manufacturers.

PROJECTILES USED BY THE SECESSIONISTS.—The Sawyer projectile, is a shell of iron covered with a soft composition, and with flanches intended to fit the grooves of the rifle instead of having the metal expanded by the force of the powder, and to which latter arrangement it has given way. The peculiarity of the Shenkle projectile is in supplying the place of the soft metal on the base by papier-maché. Both are of an elongated shape and pointed. An Infernal Machine has been found used by the Secessionists. It consists of an iron cylinder about 6ft. long and 2ft. in diameter, and perfectly water-tight. This is filled with 300lbs. of powder. It is attached by ropes 6ft. long to an empty hogshead which supports it in the water, the side of the hogshead being exposed. An elastic tube is fitted water-tight, and connects the interiors of the magazine and barrel; through this tube the fuse runs, which is lighted through an aperture in the exposed side of the hogshead, and which, burning down till it reaches the cylinder, explodes it. The fuse would burn two hours. After being lighted and set loose, it was intended to float with the tide till it reached a vessel, and there remain, finally exploding. It was a very uncertain arrangement. There were two fastened by a rope several hundred feet long, but the other was lost.

LAUNCHES OF STEAMERS.

LAUNCH OF THE "ROYAL OAK" AT CHATHAM.—The iron-cased frigate *Royal Oak*, of more than 4000 tons, was launched into the River Medway on the afternoon of the 10th ult. As the *Royal Oak* is the first of the iron-cased ships launched from any of the Royal dockyards, much interest was excited, and about 6000 spectators were present, although much rain fell during the morning. The vessel was named by Miss Fanshawe, daughter of the captain superintendent of the dockyard, and was successfully launched about five minutes before two o'clock, the spring tide having risen 18ft. 4in., with the wind blowing north. The *Royal Oak* was commenced in September, 1858, on the lines of Sir Baldwin Walker, for 91 guns, and in September, 1861, the alteration was made in her of removing the upper deck. She was cut amidships, and lengthened 16ft.; she was thereupon framed with timber, originally designed for a wooden line-of-battle ship, and now forms a class of a vessel between the *Hector* and the *Warrior* classes, but unlike both of these, as she is to be plated with armour from end to end. She is without knees at the head, and she has an upright round stern. Each of her port holes is cased round with iron plates. Those plates are two inches and a half in thickness at top and bottom, three and half inches in thickness in the centre, and twelve inches in width. Her upper deck is of iron, covered over with a wood flooring, and supported by strong iron pillars. In her present extremely light draught of water, it being 13ft. 6in. forward, and 11ft. aft, it is difficult to judge how she will appear when brought down to her load line. She has now only about 400 tons of armour plating on. When she has the whole fixed, which is about 1400 tons, as far as can now be seen, she will, when finished, be one of the most imposing ships in the navy. When in her sea-going trim her main deck portsills will be between 9 and 10ft. from the water, which will prove of great advantage in using the guns in a sea way. The dimensions of the *Royal Oak* are as follows:—Length over all, 277ft.; length between perpendiculars, 273ft.; breadth, extreme, 58ft. 5in.; depth in hold, 19ft. 10in.; burden in tons, 4045 26-94. She is to be fitted with engines of 1000 horse power by Messrs. Maudslay and Co. Her armament will consist of 34 guns, viz., two pivot guns of 100lb. each, Armstrongs, one at the fore and the other aft; the others, on her main deck, will consist of 40-pounders and 12-pounders, Armstrongs.

THE AMERICAN IRON CLAD STEAMER "PASSAIC," which has been known as Ericsson Battery No. 2 (the *Monitor* being No. 1) was launched at Greenpoint on the 30th August. The *Passaic* is of 1000 tons burthen. She is 200ft. long, 45ft. wide, and 12ft. deep; draws 7ft. of water, and will draw 9½ft. when laden. The thickness of iron, which is laid on a hull of extraordinary strength, is 5in. The turret is covered by wedges twice as heavy, being no less than 11in. thick. The mail covers the entire craft, and goes beyond the bow, where it becomes a ram. It also extends 3½ft., or half the entire draught of the vessel, below the water line. The vessel is provided with six water-tight compartments, connected with each other with suitable doorways. They are formed of 1½in. plate, but jointed and rivetted flush. The turret is 21ft. internal diameter. The plates are applied in 20 sections, and joined vertically in such a manner that there is only one joint at any one place. The turret plates rest on a flat ring, made of composition metal 1½in. thick, and 12in. wide, provided with a vertical flange on the inside 2½in. high, and 1½in. thick. The top of the turret is formed of wrought iron plates, resting on forged beams and railway bars placed 3in. apart inside the turret. The armament, which will, of course, be in the turret, is to consist of two 15in. Dahlgren guns. The machinery consists of two engines; they were built at the Delamabe iron works, and have cylinders 40in. in diameter, and 22in. stroke. The blower engines and blowers are of greater size than those of the *Monitor*, and, instead of being placed in the engine-room, are applied under the turret roof, forcing air into the boiler room and other parts of the vessel. Two boilers, of Martin's plan, are attached, of 10ft. face, 9ft. 3in. high, and 12ft. 6in. long, with three furnaces in each. The propeller is made of cast iron, 12ft. in diameter, with 16ft. pitch. The *Passaic* cost 400,000 dollars, which is the price to be paid for all her sister ships.

THE "CAMPIDOGLIO," a fine screw steamer of 450 tons, was launched from the yard of Messrs. Scott and Co., Cartsdyke, on the 1st ult. The *Campidoglio* will be employed in trading between Sicily and the Italian coast. She will be supplied with direct acting-engines of about 150 horse-power by the Greenock Foundry Company.

STEAM SHIPPING.

THE "COORONG," recently launched by Mr. J. Laurie, of Whiteinch, made a trial trip on the 12th ult. The dimensions of this vessel are—length, 171ft. 1½in.; breadth of beam, 22ft. 5½in.; depth of hold, 12ft. 2½in. The engines, which are by Messrs. Blackwood and Gordon, are of 70 horse-power, and are constructed both with common condenser and surface condenser in such a manner that a change can be made from the one to the other in a very short time, and on the passage. The speed of the *Coorong* stipulated in the contract was 10 knots per hour, but the speed attained on the trial in running between the Cloch and Cumbrae Lighthouses was 11¾ knots, being in excess of the contract 1¾ knots per hour.

THE "JASEUR."—On the 16th ult., the *Jaseur*, 5, screw steam gun vessel, 425 tons, made her official trial at the measured mile off Maplin Sands. The engines are 80 nominal and 300 indicated horse power. The trial was considered by all parties interested to be of the most satisfactory character.

THE "SHARPSHOOTER," iron gun vessel, on being docked at Portsmouth on the 19th ult., was found to have her bottom so thickly covered with oysters, that the only means to remove them was by dubbing them off with the shipwright's adzes. Flakes of shell from 18in. to 2ft. square, were got off in this manner, in all cases bringing off with them a considerable amount of the scale of the iron from the vessel's plates.

THE "ARGUS," 6, paddle-wheel steam sloop, 981 tons, 300 horse-power, was inspected on the 20th ult., and immediately after the inspection, proceeded to the measured mile off Maplin Sounds for the trial of her machinery. The force of the wind was from 6 to 7, and the wind rough. Draught of water forward, 13ft. 9in.; aft, 15ft. 6in. Average speed per hour, 8·459 knots; revolution of engines, 16·20; pressure of steam, 15; vacuum, 25. The vessel went round the circle in 5 min. 37 sec., the diameter of circle being 350 yards. There were no hot bearings, although the engines were worked at full speed for three hours.

THE "RESISTANCE," 18, screw iron frigate, was placed in dock at Portsmouth on the 9th ult., and her bottom was found to be in a most extraordinary state for a vessel on the home station, bearing more the appearance of having gone through a long commission on the African coast. The entire bottom of the ship was covered with weeds and long grass of every kind and colour, with patches of mussels here and there on the port side, together with a good sprinkling of barnacles. On the starboard side, however, the barnacles extended from stem to stern, with an immense quantity of weeds and long grass, the latter in some places, as under the quarter, full three feet in length, the mussels extending fore and aft. From the stem to abreast the fore chains on this side, about three feet below the water line, a belt of mussels adhered to the ship's bow, of from two to five inches in thickness. The whole of the composition which had been laid on to protect the iron on this side appears to have been destroyed, and patches of rust have eaten their way through. The ship's bottom was originally coated on each side with different protective compositions.

Steam-vessels for the Peruvian Government.—Messrs. Samuda, of Blackwal are busily engaged in the construction of floating docks, iron steam-vessels, &c., for th Peruvian Government, with a view to the more complete navigation of the River Amazon, and to develop the resources of the vast region on the Atlantic side of the Andes. The two first iron paddle-wheel steamers, having been fully completed for service, left the river on the 12th ult. for their destination, viz., the Morond, Capt. Ferreyros, and the Pastara, Capt. Pareja. They are each of 500 tons burden, have been fitted with the most improved engines and machinery of 150 horse power, by Messrs. Penn, of Greenwich, and on a recent trial trip from the Thames to Dover performed sixteen statute miles per hour. Two small iron steam-vessels have also been constructed at the premises of Messrs. Samuda, for the purpose of navigating the inland tributaries of the river Amazon. These vessels draw but 16 inches of water, and will be sent out in compartments and rivetted together for service on arriving at their destination. The President and Government of the Republic of Peru are about to establish a steam factory and depôt at a point 1500 miles from the mouth of the Amazon, with every appliance for repairing boilers, machinery, &c.; and the whole of the material, consisting of powerful steam-engines, machinery, &c., as also an immense iron floating dock, is now being prepared by Messrs. Samuda. The small steamers referred to as intended for the navigation of shallow waters are constructed of steel plates, and are models of ship-building.

Screw Steam Hopper Barge.—Experiments have recently been made for the purpose of ascertaining the capabilities of a screw steam hopper barge, constructed by Messrs. Richardson and Co., Low Walker (the engines by Messrs. R. and W. Hawthorn), from the designs and specifications of Mr. Ure, the engineer of the River Tyne Commission. The object of a hopper barge is to carry out to sea the sand dredged from the bed of the river, and then to let it fall through the bottom into deep waters, where there is no chance of its being washed back again into the river. The old (and, until now, universally adopted) arrangement was to have these barges towed one or two at a time by ordinary tug-boats; and the object which Mr. Ure had in view, in getting the present steam hopper constructed, was to reduce the first cost, and the cost of working, by having the cargo of sand and the propelling power in one vessel. This has been most satisfactorily accomplished—as the vessel took out 300 tons of sand from the ballast ground, 4 miles from the large dredger, in Shields harbour, and returned, after discharging her load, in one hour—her speed, when light, being 9½ statute miles per hour, and when loaded about 8½. She then took a loaded hopper barge of the ordinary construction in tow, being loaded at the same time herself, and tried her speed against one of the most powerful of the Commissioners' tugs, towing one ordinary hopper barge loaded; and under these conditions she had a decided though slight advantage in speed; that is to say, she carried 600 tons to sea in the same time as, under the old system, a load of 300 tons was carried; and when regularly working with a barge to tow, she could load, take out to sea, and return once in every two hours and a half; thus getting rid of 2400 tons in 10 hours. Everything about the vessel worked satisfactorily, and she was at once set to her regular work; in which, it is to be hoped, she will successfully assist in that development of river improvement.

TELEGRAPHIC ENGINEERING.

The Atlantic Telegraph.—It will be recollected that some months since, at the instance of the Atlantic Telegraph Company, the Lords of the Admiralty ordered the paddle wheel steam surveying vessel *Porcupine*, 3, to be prepared for sounding that portion of the bed of the ocean, near Ireland, on which the electric cable, laid by Sir Charles Bright, is supposed to have broken. Officers of experience were appointed to undertake this important duty, and an efficient crew were selected from the surveying ship *Fisgard*, 42, at Woolwich. The *Porcupine* was supplied with ample sounding machines, including those of the *Bulldog* pattern, which bring up some of the bottom each time they are used, and with a donkey steam-engine on deck for hauling them on board. The *Porcupine* left Plymouth for the scene of her labours on the 22nd of June, arrived at Galway on the 9th of July, and departed therefrom on the 21st. She proceeded to what is termed the Cliff, about 200 miles west of Galway, and during her operations there experienced a heavy gale of wind, which carried away her rudder head. The *Porcupine* put back to Galway on the 26th of July, had her rudder repaired, and on the 6th of August sailed for Rockall bank, some 500 miles north-west of Donegal Bay, where she arrived on the 14th, and after remaining two days went into Killibeg's Harbour, Donegal, for fuel, and departed on the 24th for Queenstown, which was reached on the 30th. After staying till the 3rd inst., she returned to Plymouth. One of the objects of visiting the cliff was to ascertain the exact nature of its declivity, considered to be about 1200 fathoms in eight miles, or a fall within that distance from a depth of 550 fathoms to a depth of 1750 fathoms. It is stated that the officers, by sounding crossways, have also discovered what the seamen term a "gap," through which a wire could be laid with less risk than where Sir Charles's wire was laid. They also discovered a steeper cliff, which they have named the Porcupine Rock. Some of the soundings extended to a depth of 2500 fathoms. The visit of the steamer to Rockall on the 14th of August seems to have been prompted by a desire on the part of the Lords of the Admiralty to be able to judge, by a knowledge of its depth and character, of the expediency of dropping a cable across this bank for the purpose of connecting Ireland with Iceland and America. On the ridge of the bank soundings varied from 90 to 160 fathoms; fish were most abundant; the bottom consisted of mud and sand. It is reported to be the opinion of several of the officers on board the *Porcupine* that a line of communication which can be established without the necessity of so long a wire as that direct across the Atlantic will be much more likely to succeed. A system of comparatively short lengths can be repaired with less difficulty in case of injury; besides which it is believed that with the present limited extent of telegraphic science there is no means of transmitting a message rapidly through a great length of wire. One word is said to overtake another, and it is averred that the force requisite to be exerted by the batteries for sending the fluid so great a distance must involve injury to the wire by the necessary intensity of the electric spark.

RAILWAYS.

The Portpatrick Railway, which is only seven and a half miles right across the Peninsula, has cost about £90,000. The principal piece of mason work is a viaduct of fourteen arches, and from 90ft. to 100ft. high, crossing the Piltanton Burn, at a short distance from Colfin Station. This station, which lies about half way on the new railway, is the apex of the line. For half a mile below this place the incline is 1 in 240; then there is, for a short space, an incline of 1 in 64; and from Pinminnock down to Portpatrick it is 1 in 57; and on the beach, thence down to the harbour, as steep as 1 in 35. There are also some heavy cuttings on the new line, the greater of which is that half a mile above Portpatrick. This cutting is nearly three quarters of a mile in length, and is through the solid rock, the entire of which had to be blasted.

Grand Trunk Railway of Canada.—The London Directors have received the accounts from Canada for the half-year ending the 30th of June, 1862. The total revenue amounted to £382,992 12*s.* 10*d.*, and the total expenses to £319,556 9*s.* 5*d.*, or at the rate of 83½ per cent. The profit of this half-year, added to that of the previous six months, makes the profit for the year ending 30th June, 1862, £159,144 1*s.* 11*d.*

RAILWAY ACCIDENTS.

Accident on the Midland Railway.—On the night of the 28th August, an accident occurred on this line, at Market Harborough, by which two passengers were killed and a great many injured. Two excursion trains left London that night—one for Burton and the other for Manton. The trains were of considerable length, and very heavily laden. To pass through the station at Market Harborough, the Midland trains run for nearly half a mile on the London and North-Western line. On arriving at the junction at Market Harborough, the Burton train, which started first from London, stopped to take in water. During this stoppage, the Manton train came up and dashed into the other, smashing three of the last carriages to pieces.

Accidents on Railways.—During the year 1861, 284 persons were killed, and 883 injured by accidents on railways in the United Kingdom. Of this number 216 were killed, and 836 injured in England and Wales; 39 were killed, and the same number injured, in Scotland; and 29 were killed, and 8 injured, in Ireland. Forty-six passengers were killed and 781 injured from causes beyond their own control.

BOILER EXPLOSIONS.

Association for the Prevention of Steam Boiler Explosions.—At the ordinary monthly meeting, held on September 2nd, 1862, the chief engineer presented his monthly report, of which the following is an extract:—"During the past month the ordinary visits of inspection have been made, and 8 boilers tested by hydraulic pressure, the following defects being discovered in the boilers examined:—Fracture, 3 (2 dangerous); corrosion, 26 (6 dangerous); safety-valves out of order, 14; water gauges ditto, 10; pressure gauges ditto, 13; feed apparatus ditto, 4; blow-off cocks ditto, 37 (1 dangerous); fusible plugs ditto, 6; furnaces out of shape, 3; blistered plates, 2. Total, 118 (9 dangerous). Boilers without glass water gauges, 4; without pressure gauges, 16; without blow-off cocks, 11; without back pressure valves, 31. The principal cases of dangerous injury which have arisen this month have been due to corrosion, the continued recurrence of which shows the importance of having all boilers examined, not 'externally' only, but also 'internally and thoroughly.' Another explosion has occurred during the last month to the class of plain cylindrical egg-ended boilers, fired externally. The boiler in question, which was not under the inspection of this Association, was one of a series of six connected together, in the midst of which it had worked, being the fourth from one end, and the third from the other. Its length was 30ft., its diameter 5ft., the thickness of its plates three-eighths of an inch, and its working pressure 50lb. The rent, as is usual in these cases, occurred at one of the transverse seams over the fire, but the development of the line of fracture was somewhat peculiar. In ordinary cases these boilers, on explosion, separate at one of the ring seams into two distinct halves, which fly in opposite directions; but, in the present instance, the first belt of plates was completely severed from the remainder of the boiler and flattened out, having rent through the line of rivets at each of its four edges, while the egg-end had become entirely disengaged from it, and, in addition, was torn into two parts. The remainder of the boiler, which was by far the greater portion, being about 24ft. long, had flown to a distance of from eighty to ninety yards, and the chimney, which was reduced to a heap of ruins, had either been swept down by it in its course, or blown down by the impact of the steam. There was no evidence of there having been either deficiency of water or excess of pressure; while each boiler in the series was fitted with two lever safety valves of three inches diameter, a glass water gauge, and a back-pressure feed valve. The exploded boiler was about four years old, and had been repaired seven months since, at the part immediately over the furnace, by the introduction of two new plates. It will be observed that the above explosion is another instance of the liability of these externally-fired boilers to rend at the transverse seams over the fire. The combined duty thrown upon these seams is so great, that there is more uncertainty with these boilers than with those of the internally-fired double-furnace class in ordinary use in Lancashire. All the points in the latter can be so entirely mastered that they may be thoroughly relied on, and if well made, and in sound condition, can, with proper care in working, be guaranteed as safe for a period of twelve months from the time of examination. Not so, however, with the externally-fired boiler, in which the shell has to endure the entire disruptive strain combined with the direct impingement of the flame. In the internally-fired boiler these two duties are divided; the shell, which bears the tensile strain, being guarded from the intense action of the fire, which the furnace tubes are adapted to bear, from their small diameter and facility for strengthening, either by flanged seams, hoops, or otherwise; while the deposit, which to a great extent rolls off the furnace crowns, and falls harmlessly to the bottom of the boiler in one case, deposits itself immediately over the fire in the other. Thus the seams of rivets in externally-fired boilers have to contend with the combined influence of tensile strain, the direct action of the fire, and too frequently with an accumulation of incrustation tending to overheating, and even where this does not form a positive coat, it may yet suffice so to thicken the water that the steam lifts it from the surface of the plate, when over-heating unavoidably ensues; added to which sudden draughts of cold air, on opening the furnace doors, cool the outer laps of the plate at the seams, which thus become subjected to the constant alternations of expansion and contraction. Under these circumstances it is not surprising that the seams of rivets in under-fired boilers should frequently be found suddenly to give way, for which the surest remedy will prove to be the substitution of internally-fired boilers in their place."

GAS SUPPLY.

The Manchester City Council have resolved that the price of gas to consumers within the city shall be reduced. When the quarterly consumption is under 500,000 cubic feet, to 3*s.* 9*d.*; 500,000 and under 1,000,000 cubic feet, to 3*s.* 8*d.*; 1,000,000 and under 1,500,000 feet, to 3*s.* 7*d.*; 1,500,000 and upwards, to 3*s.* 6*d.* per thousand.

The Walsall Commissioners, at the recommendation of their Gas Committee, have resolved to reduce the price of gas as follows:—To consumers of less than 25,000 cubic feet, per quarter, from 3*s.* 4*d.* to 3*s.* per 1,000 feet; 25,000 feet and less than 100,000, from 3*s.* to 2*s.* 10*d.*; and 100,000 feet and upwards, from 2*s.* 10*d.* to 2*s.* 8*d.*

The Portsea Island Gas Light Company have resolved on a dividend of 8 per cent. per annum, free of income tax. The quality of their gas has been tested, and found to be 7½ per cent. above the required parliamentary standard. The company are erecting a tank, by contract, at a cost of £13,000.

The Pangbourne Gas Works have been opened. The mains are taken to Whitchurch, and it is expected the consumption there will equal that of Pangbourne. The engineer asserts that any compact village of 1,000 inhabitants may have gas works paying 7 to 8 per cent.

The Oxford Light and Coke Company have declared a dividend of 7½ per cent.; and the Bury St. Edmunds Gas Company one of 10 per cent.—The Wick and Pulteney Gas Light Company have resolved to reduce the price of their gas from 12*s.* 6*d.* to 10*s.* per 1,000 cubic feet.—The Wolverhampton Gas Company have declared a dividend at the rate of 10 per cent. per annum, besides placing a considerable balance to their reserve fund.—The South Shields Gas Company have declared a dividend at the rate of 9 per cent. per annum.

WOOD-GAS.—A very beautiful gas, made from pine wood, is to be seen at the Cremorne Gardens, in Fourteenth-street, New York. The apparatus in which this gas is generated, is the invention of Mr. Mark Levy. It is said that the bye products from the distillation of wood, such as tar, pyroligneous acid, &c., are sufficient to pay the whole expense of the process, thus leaving the gas clear profit to the manufacturer. The retort of Mr. Levy is of a pecular construction, containing re-heating cells, by which a larger amount of gas can be obtained than in the plain retorts of the old shape.

THE MANUFACTURE OF GAS IN THE UNITED STATES.—The manufacture and consumption of gas, for illumination and other purposes, which is one of the remarkable fruits of chemical science, has been greatly increased, not only in the northern cities, but in the large towns and villages throughout the Union. The quantity returned, in the census of 1860, is but four thousand million feet, of the value of eleven million dollars, but the whole quantity made exceeded 5,000,000,000 cubic feet, the value of which was about thirteen millions of dollars.

GAS IN SPAIN.—In the city of Madrid, Spain, the consumption of gas has rapidly and steadily increased. The quantity of gas yearly consumed in that city since 1857, is as follows:—

1857	1,926,000	cubic metres.
1858	2,039,000	„ „
1859	2,345,000	„ „
1860	2,700,000	„ „
1861	3,074,000	„ „

WATER SUPPLY.

VENETIAN WATER CISTERNS.—The city of Venice is wholly supplied with rain water, which is retained in cisterns. The city occupies an area of about 13,000 acres. The annual average fall of rain is 31 inches, the greater part of which of collected in 2077 cisterns, 177 of which are public. The rain is sufficiently abundant to fill the cisterns five times in the course of the year, so that the distribution of water is at the rate of 312 gallons per head. To construct a cistern after the Venetian fashion, a large hole is dug in the ground to the depth of about 9ft. The sides of the excavation are supported by a framework made of good oak timber, and the cistern has thus the appearance of a square truncated pyramid with the wider base turned upward. A coating of pure and compact clay, 1ft. thick, is now applied on the wooden frame with great care; this opposes an invincible obstacle to the progress of the roots of any plants growing in the vicinity, and also to the pressure of the water in contact with it. No crevices are left which might allow the air to penetrate. This preliminary work being done, a large circular stone, partly hollowed out like the bottom of a kettle, is deposited in the pyramid with the cavity upward; and on this foundation a cylinder of well-baked bricks is constructed, having no interstices whatever, except a number of conical holes in the bottom row. The large vacant space remaining between the sides of the pyramid and cylinder, is filled with well-scoured sea sand. At the four corners of the pyramid, they place a kind of stone trough covered with a stone lid pierced with hole. These troughs communicate with each other by means of a small rill made of bricks, and resting on the sand; and the whole is then paved over. The rain water coming from the roofs of the buildings runs into the troughs, penetrates into the sand through the rills, and is thus filtered into the well hole by the conical holes already described. The water thus supplied is limpid, sweet, and cool.

BRIDGES.

RAILWAY BRIDGE AT CALCUTTA.—The East Indian railway bridge over the Hooghly, at Calcutta, as designed by Mr. Turnbull, is half-a-mile in length, with five whole suspension spans of 400ft. each, and two half spans of 200ft. It will be approached on either side from the railway by inclines of 3½ miles, and the gradients will not be greater than 1ft. in 300ft. Between the suspension rods below there will be a width of 14ft. for the passage of trains, and above this a width of 20ft. for ordinary carriage and pedestrian traffic. To permit the passage of the largest river steamboats with lowered funnels, there will be a clear distance of 25ft. between the bridge and the water. The estimated cost is £280,000.

MARPLE VIADUCT.—The event of keying in the last arch of the Marple viaduct, on the Hyde and Marple Extension Branch of the Manchester, Sheffield, and Lincolnshire Railway, recently took place. The ceremony of setting the stone was performed by Mr. Samuel Lees, one of the directors. After the stone had been lowered and set in its place, Mr. Lees addressed the assembly at considerable length, dwelling especially upon the great contrast in the length of time taken to construct the present viaduct, and that of the aqueduct which carries the Peak Forest Canal over the same valley, and which is only distant from the viaduct about 30 yards. The first stone for the aqueduct was laid in May, 1793, and the structure completed in May 1800, having been 7 years in construction. The aqueduct consists of three arches of 60 feet span each. Its height from the bed of the river—the Goyt—being 97 feet, and it contains 8000 cubic yards of masonry; whereas the viaduct has thirteen arches, of 50 feet span each; its height from the bed of the river is 135 feet, and contains 18,000 cubic yards of masonry. It is constructed entirely of stone. The first stone was laid on the 24th September, 1861. Consequently, the time occupied in the construction of it had been rather under twelve months. The work has been carried out from the plans, and under the superintendence of Mr. J. G. Blackburne, of Oldham, the engineer of the line. The contractors are Messrs. Benton and Woodiwiss. The viaduct will be open for traffic in about a month. Mr. Lees also spoke of the very great benefit the line would confer upon the district, as it would, in conjunction with the Midland Railway from Rowsley (now in progress of being made, and which will join this line at New Mills), open out the shortest routes from Manchester to London; as also giving another and entirely independent line. It will also pass through some of the most beautiful scenery in Derbyshire, running from Marple along the valley of the Goyt to near Chapel-en-le-Frith; thence through Dove Holes Dale to Blackwell Mill, near Buxton, and thence along the valley of the Wye to Rowsley, near Chatsworth. It is expected that the Midland portion of this railway will be completed in about two years.

MINES, METALLURGY, &c.

COLLIERY ACCIDENT.—The scene of this accident was the Monkwearmouth Colliery, Sunderland, and the manner in which the men lost their lives is singular in the extreme. It appears that in one of the pits a "feeder" had burst in the side of the shaft, and measures were being taken to put it in a state of thorough security. At one part of the shaft the sides indicated a tendency to give way, and this portion was filled in for a depth of eleven fathoms with stones and rubbish to prevent accidents. Unfortunately they proved the cause of destruction instead of the means of safety. A party of six men one of whom happened to be absent just at the moment of the accident, were at work in a cradle above the portion of shaft so filled in, when the mass below fell crashing down the pit. So powerful was the rush of air caused by the fall that the cradle was drawn down as though it had been a feather, and besides the five crushed to death, two other men were severely burnt by the flames of a furnace sixty yards from the shaft, which were blown upon them by the same current of air.

APPLIED CHEMISTRY.

EFFECT OF POWDERED ICE IN WATER BOILING IN GLASS VESSELS.—The common experiment of pouring iron filings into water slowly boiling in smooth glass vessels to increase the ebullition, can be instructively varied by substituting powdered ice or granular snow for the iron filings. Snow that has thawed partially and then frozen so as to become hard and granular is the best; but powdered ice will answer, if kept so cold by freezing mixture so as to become perfectly dry. If a spoonful of this ice or snow be thrown into a smooth flask nearly filled with water slowly boiling, intense ebullition at once takes place, a portion of the water being thrown out of the flask. The particles of ice thus act like particles of iron or sand, before they have time to melt and set free the steam.

NEW GUN METAL.—The cannons newly cast in Austria for the marine service, and from which so much is expected, are formed from a new alloy called Aich metal, from the name of the inventor. It is composed of copper, 600 parts; zinc, 382; iron, 18. Its tenacity is said to be excessive; it is easily forged and bored; when cold it may be bent considerably without breaking; its resistance is far greater than that of iron of the best quality. This announcement makes us earnestly wish to learn the fate of the cannon of aluminium bronze, which M. Christope cast at his own expense, and which was so severely tried at Vincennes.

FOR THE PURIFICATION OF MERCURY, in the "Proceedings of the Société de Pharmacie," a plan of M. Barruel is given, who, when distilling mercury, places above it a layer of sand, by which means he arrests any of the metals that would pass over mechanically with the mercury vapour. M. Roussin suggested that the sand might be advantageously replaced by iron-turnings.

METALLURGICAL IMPORTANCE OF ALUMINIUM, BY M. CH. TISSIER.—The author again calls attention to the alloys of aluminium with copper. The valuable properties of aluminium bronze are well known, and it seems that the trifling proportion of one per cent. of aluminium exerts a very serviceable effect on copper. Copper thus alloyed does not oxidise during tapping, and can be moulded into forms the surface of which remains brilliant. According to M. Tissier, the alloy of 99 of Minesota copper and 1 of aluminium, compared to pure copper (doubtless the same copper), gives, in testing the flexibility of a round bar of 0·050 by 0·006 millimètres, the following results:—

	Kilogrammes.
Copper with 1 per cent. of hammered aluminium	19
Pure copper, wire drawn	7
Brass, wire-drawn	8

These weights indicate the limit of elasticity. A ternary alloy gave the following results:—

Copper.	Tin.	Aluminium.	Kilogrammes.
96	4	0	4
96	4	1	10
96	4	1	16

Ordinary cannon bronze (copper 89, tin 11, melted, gave 10, like the second alloy in the table. If these results are confirmed, they will prove that the proportion of aluminium may be less than that admitted by MM. Deville and Debray, and yet give excellent products.

ON THE STRUCTURE OF COPPER, Mr. W. Vivian writes as follows:—"I have explained that all manufactured copper showed a porous or cellular structure, and I have now to state that native copper generally shows a crystalline structure; indeed, like all copper the produce of cementation, our native coppers are an aggregation of crystals. The structure of the native copper of the Lake Superior district of North America is, however. very different from other native or manufactured copper; it is neither cellular nor crystalline, but dense, ductile, and wiry in structure, giving the idea of its having been moulded and forced into its present shape while in a cold state, and in this respect it perfectly resembles native gold and silver; and it is remarkable that the same copper when once melted assumes the cellular structure of all other manufactured copper. Now it seems to me that the proper inference to be drawn from the above peculiarity in structure is, that this native copper is not deposited from a solution like our native copper, neither was it deposited under the agency of fire, else it would have been either crystalline or cellular in structure, unless it has undergone some other very material change."

A NEW METAL IN THE NATIVE PLATINUM OF ROGUE RIVER, OREGON.—By C. F. Chandler.—In examining native platinum from the above locality, more than a year ago, I became convinced of the probable existence of a hitherto unobserved metal. I have deferred publishing my observations, hoping to obtain material for a more complete examination; in this I have thus far been disappointed. The quantity of platinum examined amounted to only a few grammes. It was digested with hydrochloric acid to remove impurities, and the solution thus obtained was subjected to the ordinary routine of qualitative analysis. A brown precipitate was produced by hydro-sulphuric acid, which dissolved readily in hydro-chloric acid on the addition of a crystal of chlorate of potassa. In this solution metallic zinc produced a precipitate which resembled metallic tin obtained under similar circumstances. This precipitate dissolved readily in hydrochloric acid on the application of heat; but the solution thus obtained had no effect on a solution of protochloride of mercury ($HgCl$), and on cooling deposited a small quantity of minute crystals. To guard against error, these experiments were repeated two or three times on small portions of the original solution, always with the same result. The chloride of this metal differs therefore from the protochloride of tin in not reducing protochloride of mercury to calomel, and in being but slightly soluble in the cold. On mentioning my observations to a friend, I was referred to Dr. F. A. Genth's announcement of a new metal, made in 1852, of which I was not previously aware. The metal observed by Dr. Genth occurred among grains of platinum from California. It was malleable; it fused readily on charcoal before the blowpipe, becoming covered with a coating of black oxide; it dissolved in borax to a colourless bead, which became opalescent on cooling; it was dissolved by hot hydrochloric acid and by nitric acid, and its solution gave a brown precipitate with hydrosulphuric acid. It seems quite probable, therefore that the metal which I have observed in the Rogue-River platinum is identical with that observed by Dr. Genth.

SEAMLESS COPPER TUBES.—Some of the seamless tubes, made ostensibly from copper, appear to be formed of an alloy. This is the more probable because copper cannot readily be cast into the hollow ingots from which the tubes are to be drawn. Pure copper, in its melted state, has a pudding-like consistency, and when cast is likely to come out unsound. In alloying it, to increase its fluidity when melted, the metal is not only debased, but it loses much of its malleability. At a seamless tube works, near New York, pure copper is cast into sound tubular ingots by running the fluid metal into moulds revolving some 2,000 turns a minute. The centrifugal force thus imparted to the metal condenses it upon the inner surface of the mould, and experience, in the use of the tubes thus cast, shows that perfect soundness is thereby attained. The refining furnace is set up close by the moulds, of which there are twenty, more or less, disposed radially around a central shaft, the axis of each mould lying horizontally. A large friction wheel on an upright shaft gives motion to all the moulds. A measured quantity of metal from the furnace is poured successively into the end of each mould, the result being a tubular ingot, of say 1ft. length, 4½in. in diameter, and having a beautiful smooth cylindrical hole of about 3in. bore throughout its length. When cold this ingot is heated and rolled upon a loose mandril, between four rollers so disposed as to embrace its entire circumference. After being thus rolled out to a length of 2ft. the process is repeated until the length is increased to 3ft. or 4ft. After annealing it it is then drawn successively through dies of gradually diminishing size until the tube has been brought to the required diameter and length. A single pass through a smoothing die completes the process.

COATING SHIPS' BOTTOMS.—To prevent adhesion of animal and vegetable matters to ships' bottoms, Mr. Robert Johnson, of Liverpool, proposes to apply a composition consisting of mercurial or blue ointment (a mixture of mercury and fatty matter), 2lbs.; powdered arsenic, 2lbs.; powdered black lead, 6lbs.; coal tar, or black varnish, 1 gallon; the whole of the ingredients are well mixed and applied to the ships' bottoms.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTIZAN."

DATED AUGUST 25th, 1862.

2361 M. J. Haines—Driving-bands or straps.

DATED AUGUST 26th, 1862.

2362 H. R Hughes—Sawing machines.

2362 W. E. Gedge—Stays or corsets.

2364 J. & B. Harrison—Clod crushers.

2365 G. Davies—Machines for washing skeins of cotton, linen, wool, or silk.

2366 T. Richardson & R. Allinson—Treatment of articles of steel.

2367 L. Tarossou—Washing textile fabrics.

2368 J. Rider—Fencing posts or standards.

2369 A. V. Newton—Instrument applicable to the cleaning of windows.

DATED AUGUST 27th, 1862.

2370 A. Crichton—Looms for weaving ornamental fabrics.

2371 G. Davies—Singeing woven fabrics of cotton, wool, or silk by means of gas or alcohol.

2372 H. Harben—Manufacture of paper and other productions in which fibrous material is employed.

2373 J. A. Coffey & T. Redwood—Manufacture of salts of ammonia and other products from the ammoniacal liquors of gas works and animal charcoal works.

2374 R. Sims—Apparatus for pulping, stripping, or slicing turnips and other vegetable substances.

2375 W. H. Turner—Carding cotton.

2376 C. Clark—Tea trays and urns.

2377 G. Lindsay—Mode of arranging and disposing guns in ships employed in naval warfare and otherwise.

2378 W. M. Mayes—Addition to wheels of railway and other carriages.

2379 R. A. Brooman—Sorting and washing coal and other minerals.

2380 W. E. Newton—Method of producing light.

2381 J. E. Nutting—Buttons.

2382 A. V. Newton—Printing from engraved plates.

2383 H. W. Cook—Apparatus for obtaining motive power.

2384 J. J. Potter—Upright pianofortes.

DATED AUGUST 28th, 1862.

2385 J. Kitchin—Ventilators.

2386 M. A. F. Mennons—Smoke consuming furnaces.

2387 M. A. F. Mennons—Assorting apparatus for numbering raw silks.

2388 G. Biddle—Brooms.

2389 J. J. Noeckel—Apparatus for spinning cotton, wool, or other fibrous materials.

2390 E. Lachenal—Gas meters.

2391 W. Husband—Water valves.

2392 G. Cooke—Apparatus for securing or fastening doors to prevent intrusion.

2393 C. Humfrey—Treatment of petroleum to render it non-inflammable.

DATED AUGUST 29th, 1862.

2394 P. L. Gilbaud & N. V. Thiré—Self-inking hand stamp.

2395 H Jones—Breach-loading fire-arms.

2396 F. H. Lefranc—Casks.

2397 W. Smith—Furnaces.

2398 J. Davis—Spoons and forks.

2399. H. Harben—Manufacture of cotton and cotton fibre.

2400 G. W. Dyson—Machinery for finishing and polishing circular metal rods, bars, and shafts.

2401 W. Owen—Railway wheels and tyres.

2402 P. W. Mackenzie & S. W. Smith—Vehicles to be propelled by the rider.

2403 R C. Bishop—Motive power.

2404 W. Upfill, W. Morton, & W. Asbury—Wheels and axle-trees for carriages.

2405 E. A. Pontifex—Steam traps or apparatus for facilitating the escape of condensed steam.

DATED AUGUST 30th, 1862.

2406 E. T. Hughes—Woven fabrics.

2407 E. C. Harding & C. Doody—Braces.

2408 F. le Conte—Furnaces for steam boilers.

2409 W. E. Gedge—Machinery for manufacturing velvet

2410 J. H. Johnson—Coating or covering metallic surfaces with copper.

2411 J. Meyrr—Mechanism for the production of Jacquard cards and card bands.

DATED SEPTEMBER 1st, 1862.

2412 J. G. N. Alleyne & J. Roberts—Manufacture of flanged wrought-iron or steel plates, or of wrought-iron beams and frames of a trough-shaped section.

2413 J. Nickson and T. Waddingham—Foundation or groundwork for plaster for ceilings, walls, and partitions.

2414 J. Walker—Treatment of kelp.

2415 W. E. Gedge—Apparatus for washing the felts of paper-making machines.

2416 J. Ellis—Corsets.

2417 J. Whitehead—Machinery for preparing, spinning, and doubling cotton, wool, and other fibrous materials

2418 E. G. Fitton—Machinery for winding yarn or thread on to bobbins or spools.

2419 J Watt & T. S. Haviside—Process for cottonising certain vegetable fibrous substances.

2420 W. C. Edge—Mode of securing Albert chains to the vest of the wearer.

2421 W. Clark—Means of obtaining light and heat.

2422 J. H. Johnson—Manufacture of braid.

2433 J. H. Johnson—Apparatus for regulating the working of motive-power engines, applicable also to the regulation of the flow of liquid, air, or gas through pipes or conduits.

DATED SEPTEMBER 2nd, 1862.

2424. D. B. Peebles—Wet gas meters.

2425 J. Mosheimer—Machinery for amalgamating gold and silver.

2426 W. Hunt—Manufacture of muriate of ammonia.

2427 H. R. Trigg—Fire escape.

2428 R. Glanville—Marine and other engines.

2429 R Waygood—Steam boilers.

2430 W. Roberts—Apparatus for regulating the amount of water discharged by a pump.

2431 J. B. Thompson—Electro-magnetic machines.

2432 Sir W. O'S. Brooke—Submarine telegraph cables.

2433 A. Johnston—Machinery for pressing cotton and other materials.

DATED SEPTEMBER 3rd, 1862.

2434 C. Garton—Method of applying heat in the manufacture and refining of sugar, and of malting, hop drying, brewing, distilling, and vinegar making.

2435 H. Elliott—Instrument for extracting the cases of pin cartridges from breech-loading fire-arms, and for recapping, recharging, and closing or turning in the said cartridge cases.

2436 F. C. Bakewell—Fire-places and stoves.

2437 G. Walton—Circular box looms.

2438 W. H. Atkinson—Studs or fastenings.

2439 W. Clark—Musical instruments.

2440 E. Dyson—Throstle spinning and doubling machines.

2441 R. A. Brooman—Tools for boring, and apparatus for working the same.

2442 R. A. Brooman—Transmitting electric telegraph messages and signals.

2443 P. J. Bossard—Stoppers for bottles, jars, guns, and tubes.

DATED SEPTEMBER 4th, 1862.

2444 J. Cook—Carriages.

2445 B. F. Cowan—Cannon and other fire-arms.

2446 W. Clark—Manufacture of colouring matters

2447 J. Platt & W. Richardson—Burning of bricks and tiles, and other articles of earthenware.

2448 H L. Emery—Machinery for ginning cotton.

2449 R P. Coles—Permanent way of railways

2450 J. Platt & W. Richardson—Preparation of clay for the manufacture of bricks, tiles, and other articles.

DATED SEPTEMBER 5th, 1862.

2451 W. Slater & W. R. R. Harris—Self-stripping carding engines.

2452 W. E. Bovill—Mode of applying oil and other fluid lubricating matters to machinery.

2443 H. W. Hart—Argand and other gas burners.

2454 D. A. Samuel—Apparatus for steering vessels.

2455 J. S. Margetson—Manufacture of the material intended for scarfs or cravats.

2456 W. Wells—Horse shoes.

2457 W. E Newton—Lamps.

2458 S. H. Hadley—Gas for illumination.

2459 J. R. Johnson & and J. A. Harrison—Photographic panoramic pictures.

DATED SEPTEMBER 6th, 1862.

2460 S H. Huntley—Cooking appararus, applicable to the requirements of the army and navy.

2461 J. Snider—Method of preserving all objects exposed to the action of acids, alkalis, gases, fire, fresh or salt water, atmospheric or other destructive influences by the application of graphite.

2462 S. Pudney—Manufacture of sulphuric acid.

2463 H. Hughes—Fluted fabric and fluting or goffering machines.

2464 E. L. Duncan—Splints.

2465 J. H. Johnson—Fire arms and projectiles.

2466 W. J. Curtis—Breech-loading cannon.

2467 W. A. Richards—Fastening.

DATED SEPTEMBER 8th, 1862.

2468 C. W. Williams—Steam boilers.

2469 F. D. Artingstall—Balances.

2470 J. S. Crosland—Copper tubes.

2471 J. Whitehead—Looms.

1472 J. Hartshorn & W. Redgate—Lace fabrics.

2473 C. Fink—Turbine.

2474 G. W. Belding—Machines for forcing fluids and dirt from cloth and other fabrics.

2475 G. Davies—Railway signals.

2466 A. J. Alderman—Ships' windlasses, capstans, and cable stoppers.

DATED SEPTEMBER 9TH, 1862.

2477 J. Webster—Preventing the incrustation of steam boilers.

2478 P. Rainier—Watches, chronometers, and other timekeepers.

2479 J. Maurice—Construction and preservation of ships.

2480 F. Selby—Traction engines.

2481 W. Hirst—Machinery to be employed in the manufacture of paper or linen spool tubes and cartridge cases

2482 J. Walker—Oil presses.

2483 T. Fl itmann—Manufacture of copper from copper ores.

DATED SEPTEMBER 10th, 1862.

2484 J. Saunders—Lamps.

2485 J. Saunders—Railway break.

2486 M. Smith—Machinery for raising the nap on woven fabrics.

2487 W. Roihera—Machinery for rivetting boiler plates, tanks, and similar articles.

2488 F. Hands & Henry Holland—Compositions for the manufacture of black ornaments, such as brooches, bracelets, ear-rings, and other ornaments made of jet.

2489 J. Vigouroux—Inoxydable metal for making taps or cocks.

2490 A. Barclay—Traction engines, and apparatus indicating the pressure of steam.

2491 G. Ritchie—Extracting the liquid portion of yeast, spent hops, or other similar matters.

2492 G. T. Bousfield—Files.

2493 A. Rigg, jun.—Apparatus for carrying and tipping coal and other minerals, and steam brakes used therewith.

2494 G. T. Bousfield—Files.

DATED SEPTEMBER 11th, 1862.

2495 W. A. Munn—Apparatus for capping, loading, and closing cartridges for breech-loading fire-arms.

2496 T. Steel—Treating soapsuds or other saponaceous or oily matters.

2497 G. Weeks—Frames, trays, pots, or holders for flowers, plants, or shrubs.

2498 C. R. Humphrey—Printing machinery.

2499 F. Datichy—Steam engines.

2500 J. Hemsley—Material for scarfs, ties, or handkerchiefs.

2501 R A. Brooman—Implements for cultivating the soil.

2502 W. Clark—Cigar and cigarette cases.

2503 L. C. Hoyau—Portable apparatus for marking time.

2504 J. Thompson—Treatment of vegetable fibres with a view to their manufacture into textile fabrics.

2505 A. Barclay—Locomotive boring and winding engines.

2506 W. Richards—Fire-arms and cartridges.

2507 J. and F. Walker—Machinery for combing and carding or hackling flax, silk, wool, and other fibrous substances.

2508 P Ward—Manufacture of a double sulphide of calcium and sodium.

2509 T. Molyneux—Pianoforte actions.

2510 A. Whytock—Construction of coated and uncoated sheet iron boxes.

DATED SEPTEMBER 12th, 1862.

2511 A. E. H. B. Butler—Machinery for straightening and polishing cylindrical bars of iron and other metals

2512 J. B Smith—Washing and mangling machines applicable to steam dyeing and bleaching.

2513 J. Thom—Mounting or fitting artificial teeth.

2514 J. R. Johnson and J. S. Atkinson—Machinery for manufacturing printing types.

2515 J. Bower—Railway sleepers.

2516 J. Rowell—Pillars and apparatus for straining wire.

2517 J. Howie—Crossings and switches of railways.

2518 A. J. Moreau—Process for reducing or melting pulverised metals or metallic ores.

2519 H. Higgins—Machinery for opening, cleansing, or carding cotton.

2520 G. Bedson—Rolling wire and other rods or bars of metal.

DATED SEPTEMBER 13th, 1862.

2521 W. Harkes—Mowing and reaping.

2522 H. J Lewis—Engines to be worked by means of water.

2523 M. Chadwick—Doubling, folding, or plaiting cloth.

2524 J. Williams—Machinery for punching, cutting, or pressing metal plates.

2525 T. W. Cowan—Pumps.

2526 A. V. Newton—Apparatus for sleeking, creasing, and raising leather.

2527 H. Bennett—Apparatus for the rolling of wire rods.

2528 W. Palmer—Lamps.

DATED SEPTEMBER 15th, 1862.

2529 E. G. Chant—Self-binding portfolios.

2530 W. G. Rawbone—Gun barrels.

2531 J. Pender—Hoops for fastening bales.

2532 E. Balurforth—Raising gigs.

2533 W. L. Tizard—Construction of ships, vessels, cupolas, and forts.

2534 H. M. Radloff—Vessels for filtering oils.

2535 J. Webster—Manufacture of nitric and nitrous acids.

DATED SEPTEMBER 16th, 1862.

2536 E. Astel—Urinary utensils.

2537 J. Whines—Machinery for filling dipping clamps with tapers and match splints.

2538 B. F. Weatherdon & E. H. C. Monckton—Engine for obtaining and applying motive power.

2539 J. G. Bunting—Mechanical horse break.

2540 G. L. Lee—Manufacture of shutters for shop fronts, doors, and windows.

2541 S. Flexen—Ventilating railway and other carriages.

2542 W. Clark—Treatment of peat and peat tar.

2543 R. Moreland, jun.—Machinery for preparing and cutting hoops

2544 R. Lakin—Plating or shielding ships of war.

2545 H. Jordan—Rotatory engines.

2546 C. E. Guye—Cutting and finishing the teeth of wheels.

DATED SEPTEMBER 17th, 1862.

2547 L. Leigh—Machinery for stretching and glossing silk, wool, and other fibrous materials.

2548 S. Le Keeler—Veneer cutting machinery.

2549 R. Cranston—Washing machine.

2550 J. Simpson—Composition for coating or covering moulded or other surfaces.

2551 W. E. Newton—Watches or timekeepers.

2552 W. & W. E. Watson—Preparation of colouring matters from aniline.

2553 J. Douglas—Kitcheners.

2554 G. Haseltine—Manufacture of gas from petroleum oil and water, or from Cannel coals, schists, tar, crude coal oil, or other hydro-carbons and water.

2555 J. H. Johnson—Gas burners.

DATED SEPTEMBER 18th, 1862.

2556 L. Mond—Obtaining hypo-nitric acid and nitric acid from nitrate of soda.

2557 P. H. Whitehead—Stand for casks.

2558 R. Kay—Printing calico.

2559 W. Todd—Machinery for collecting waste or fly from spinning machinery.

2560 W. H. Browne & H. Armstrong—Dry and wet gas meters

2561 G. S. Moore—Ship building.

2562 J. W. Woodford—Machinery for driving and drawing piles, and raising soil.

DATED SEPTEMBER 19th, 1862.

2563 T. Watts—Thrashing machines.

2564 G. Lowry—Machinery for preparing, cleaning, cutting, and shortening the lengths of tow and other fibrous materials.

2565 W. Glass—Treatmeat of sulphuret of antimony.

2566 E. de la Bastida—Conical cover or pot, a graduated apparatus for placing upon chimney tops, for preventing smoke and extinguishing fires.

2567 W. Tytherleigh—Perpetual heater for ironing or pressing.

2568 J. & W. Smith—Combination of machinery for doubling, measuring, and plaiting woven fabrics.

2569 J. Bouvet—Closing or sealing tin preserve boxes.

2570 D. C. Bridge and J. Dyson—Boilers to be employed for warming buildings.

2571 J. B. Giertz—Gas burners or jets.

2572 F. Savage—Traction engines.

2573 W. W. Cochrane—Securing the bolts and nuts of railway fish-plates.

2674 J. Imray—Telegraphing and signalling by means of electricity.

2575 R. R Jackson & J. Coupe—Looms.

2576 C. Chinnock—Corkscrews.

2577 G. Maw—Manufacture of tessero and other mosaic inlays.

2578 E. Feis—Fastenings for purses and bags.

DATED SEPTEMBER 20th, 1862.

2579 P. L. Forestier—Photographic albums.

2580 H. R. Fanshawe—Fishing.

2581 B. Hotchkiss—Atmospheric trip hammers.

2582 L. Dixey & G. Smith—Tinting by lithographic printing.

2583 J. Wilson—Composition for preventing and removing incrustations in boilers.

2584 A. Prince—Steam boiler and other furnaces, and apparatus for feeding the same.

DATED SEPTEMBER 22nd, 1862.

2585 C. Mertens—Apparatus for scutching and dressing flax, hemp, or other fibrous materials.

2586 J. Sanderson—Writing desks.

2587 H. Holdsworth—Manufacture of crinoline steel.

2588 J Long—Machine for cleansing and scraping roads.

2589 W. M. Cranston—Machinery for mowing and reaping corn.

2590 M. Vogl—Fastenings for leggings and other articles of wearing apparel.

DATED SEPTEMBER 23rd, 1862.

2591 J. & D. Mapple—Telegraphic apparatus.

2592 R. Fairburn—Machinery for combing wool and other fibrous substances.

2593 T. Knowles, J. Houghton, W. Knowles, & W Houghton—Looms.

2594 C. Pontifex—Apparatus for removing or expressing beer from yeast or from hops.

2595 W. Dobson—Producing various colours on lace or other fabrics.

2596 J. J. N. Micas—Railway break.

2597 R. A. Brooman—Lighting apparatus.

2898 R. A. Brooman—Photographic apparatus.

2599 S. H. Laurent—Railway break.

2600 W. Wilkinson—Manufacture of knitted elastic fabrics.

DATED SEPTEMBER 24th, 1862.

2601 J. Farran—Looms.

2602 W. Clark—Signals.

2603 W. Taylor—Manufacture of blacking or polish.

2604 R. A. Brooman—Manufacture of a composition for painting.

2605 W. Maddick—Method of treating and preparing madder for dyeing purposes.

2606 D. & A. Posener—Manufacture of india rubber pouches and purses.

2607 R. R. & A. I. Jackson—Preparation and treatment of flax and other fibrous materials to be subsequently operated upon by machinery employed for preparing and spinning cotton.

2608 R. R. & A. I. Jackson—Machinery for cutting fibrous and other materials.

2609 W. Upfill & W. Asbury—Manufacture of metallic bedsteads, and ornamenting tubes and curtain and cornice poles.

2610 T. Edwards—Mode of preparing fibrous materials for spinning.

DATED SEPTEMBER 25th, 1862.

2611 R. Alexander—Mariners' compasses.

2612 M. A. F. Mennons—Construction of chair settees.

2613 T. Kennedy—Taps or valves.

2614 F. Tolhausen—Improved steam cultivator.

2615 J. Raywood—Construction of gas apparatus for the prevention of fraud, and economising the consumption of gas

2616 J. R. Breach & E. B. P. Smith—Machine for reducing and equalising the length of animal or vegetable fibres.

2617 J. Eardley—Pitch pipes or tuning pipes.

2618 W. Lea—Hinges for French casements.

2619 A. Potter—Electro-magnetic engines.

2620 P. Wright—Manufacture of parallel vices.

2621 J. R. C. Taunton—Manufacture of metallic bedsteads, cots, and couches.

2622 R. G. Muntz—Manufacture of axles.

2623 T. R. Harding—Machinery for opening, cleansing, and carding fibrous material.

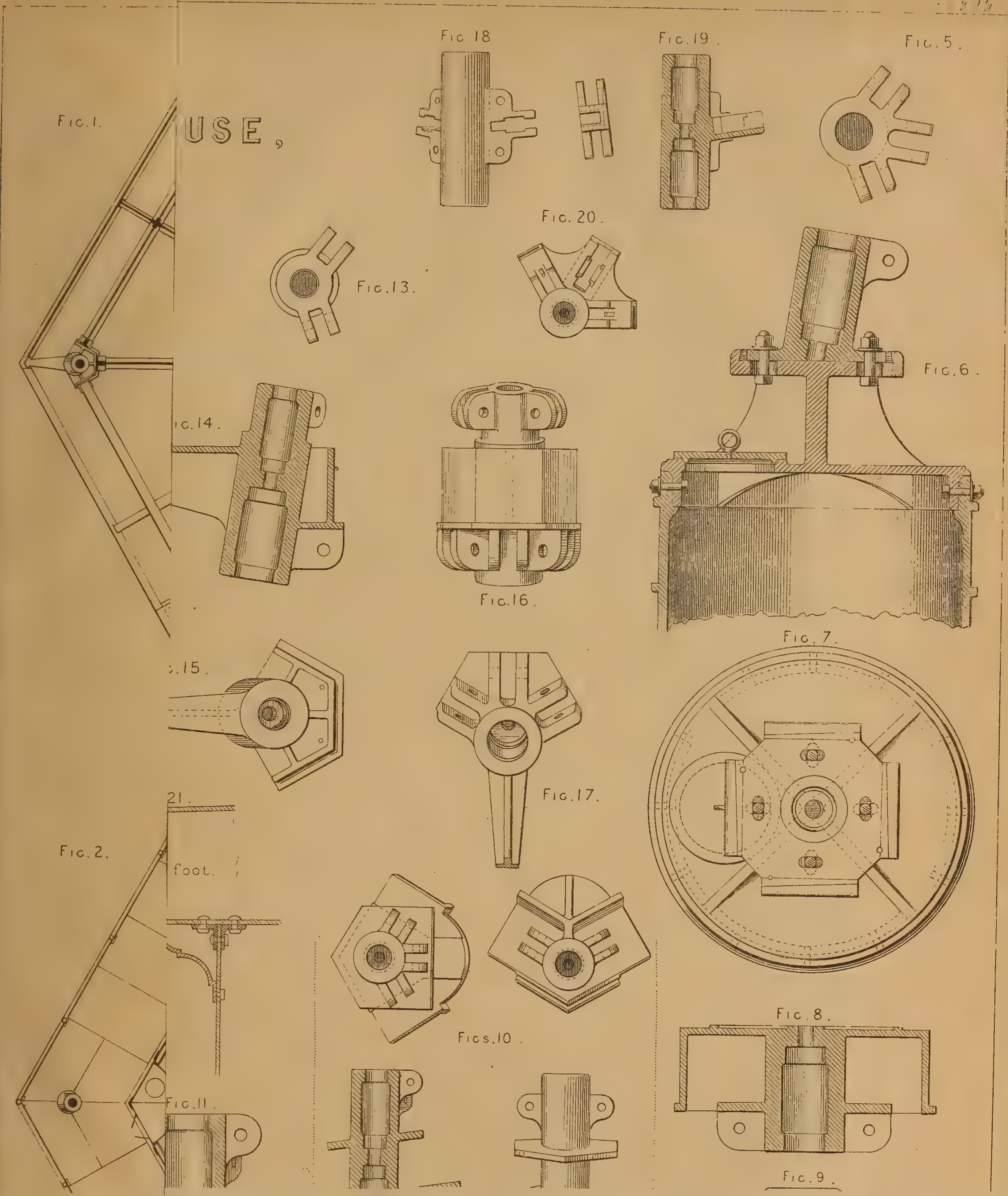
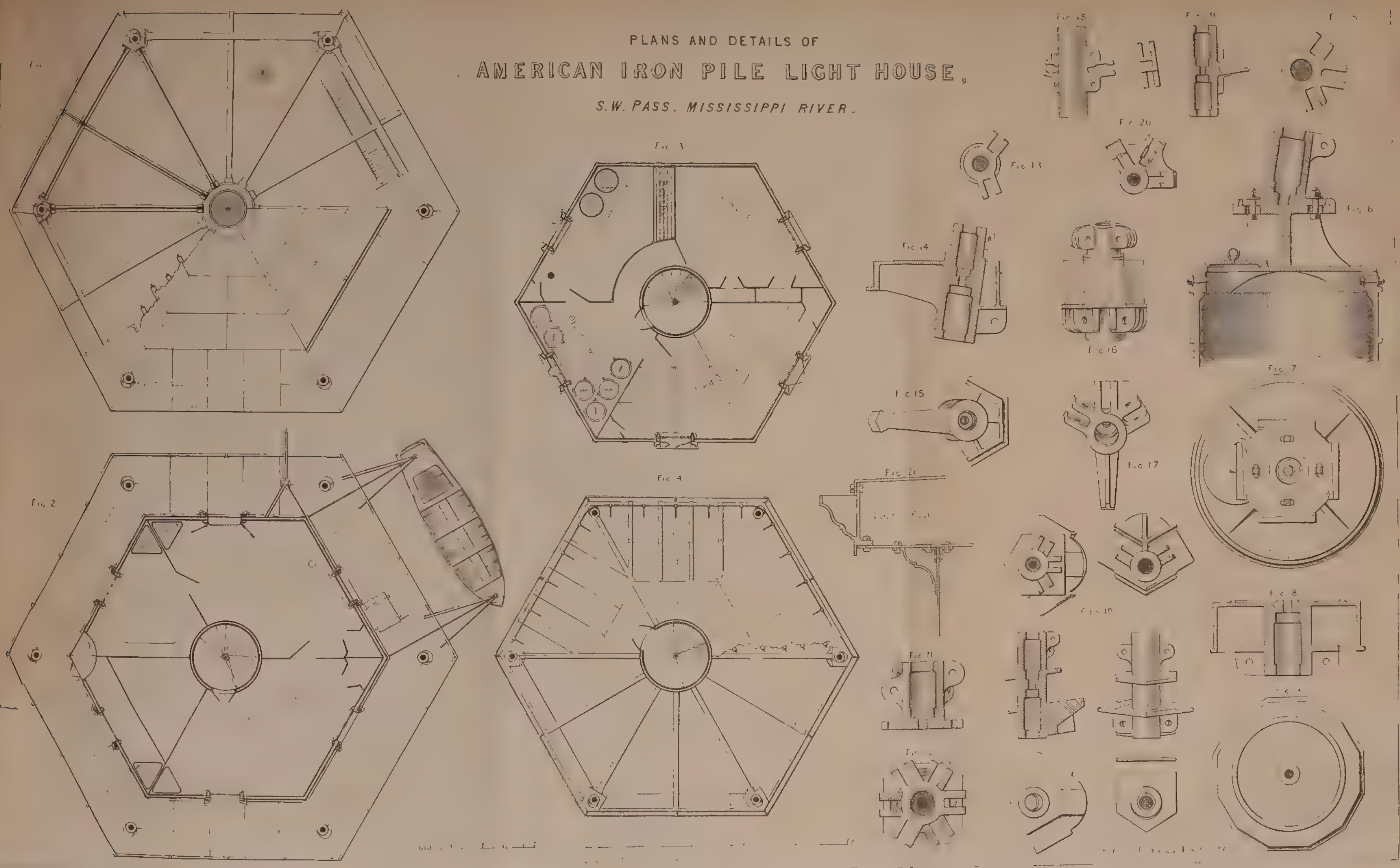


Fig. 1.
USE,
Fig 18
Fig. 19.
Fig. 5.
Fig. 20.
Fig. 13.
Fig. 6.
ic. 14.
Fig. 16.
Fig. 7.
:. 15.
Fig. 17.
21.
Fig. 2.
foot.
Figs. 10.
Fig. 8.
Fig. 11.
Fig. 9.

PLANS AND DETAILS OF

AMERICAN IRON PILE LIGHT HOUSE,

S.W. PASS. MISSISSIPPI RIVER.



THE ARTIZAN.

No. 239.—Vol. 20.—NOVEMBER 1, 1862.

AMERICAN IRON PILE LIGHTHOUSE FOR THE S.W. PASSAGE OF THE MISSISSIPPI RIVER.

(*Illustrated by Plate* 225.)

Referring to our illustration* and description of this lighthouse, given in The Artizan of August, we now present our readers with a plate, devoted to the details of the structure.

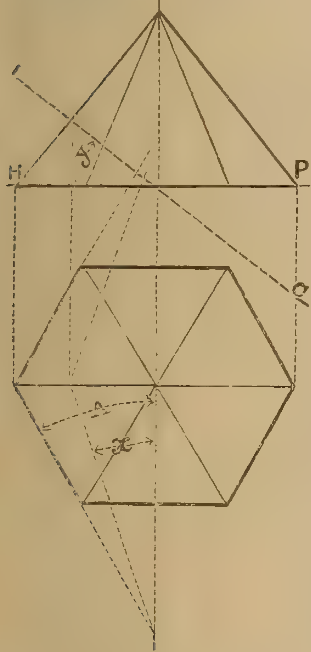


Figure 1 is a plan taken on the line D, plate 219.

Figure 2.—Plan of the keeper's dwelling, taken on the line C.

Figure 3.—Plan of second floor, taken on line B.

Figure 4.—Plan of roof, taken on the line A.

Figures 5, 6, 7, 11, and 12, are details of the first series of sockets and caps of the hollow piles.

Figures 8 and 9 are respectively a plan and section of cap socket on centre pile.

The series of views bracketed together, and marked figure 10, are the details of the sockets of the third series; figures 18, 19, and 20, being the details of the sockets of the fourth series.

Figures 14, 14, 15, 16, and 17 are details of the corner sockets of the second series.

Figure 21 is the detailed section of the cornice of the roof of keeper's dwelling.

The accompanying diagram shows a method of finding the angle contained between the inclined sides of pyramid, in order to fix the lugs for the tension bolts in their proper positions on the the sockets.

For S.W. Pass. Lt. Ho.

$$\text{Tang. } x = \text{tang. A} \times \cos. y = \overbrace{\text{tang. } 30° \times \cos. 9° 7'} = 57735 \times {\cdot}9874 = {\cdot}57007539$$

$$x = 29° 41' 10''$$

$$2 (90° x) = 2 (60° 18' 50'') = 120° 37' 40'' \text{ the angle sought.}$$

H P—Horizontal Plane.

I C—Plane perpendicular to axis of inclined column.

* Plate 219.

USEFUL NOTES AND FORMULÆ FOR ENGINEERS.

(*Continued from page* 222.)

Section VII.

The object of a machine is either to transmit, or to transmit and modify, force and motion; where it is required to transmit motion without altering its nature as from one pulley to another, the desideratum is to lose as little as possible of the driving force upon friction, &c. Prime movers are instances of the modification of various physical forces; the water wheel and water engine applies the force of gravity to machinery; the steam engine applies the force developed by the chemical combination of oxygen with carbon, hydrogen, &c.; and the electric engine applies the force produced by a current of electricity, which electricity is usually produced by the chemical combination of oxygen with a metal, as zinc, &c.

As regards the relative efficiency of steam and electric engines, it has been shown that the quantity of mechanical effect produced by the combustion of a given weight of coal is far greater than that produced by the oxidation of the same weight of zinc, therefore the application of electro-dynamic engines to purposes requiring a large amount of force is at present precluded by the advantages of the steam engine. The strains to which the various parts of machines are subject are the same as those which have already been described, but it is necessary to allow a greater excess of strength in machinery than is requisite to the safety of structures; at the same time, the working parts should not be made heavier than is necessary, so that the friction of the machine may be reduced to a minimum. The amount of friction on the various parts of a machine is very variable, and the application of mathematical formulæ to the practical determination of it is neither easy nor satisfactory; the chief cause of variation is produced by a variation in the amount of work to be performed, as the friction necessarily varies with every increment or decrement of pressure on the joints and journals, which pressure depends entirely on the amount of work being done at the moment.

The practice of taking friction diagrams from engines seems to indicate that this point has been overlooked, as such diagrams do not give a correct idea of the amount of work lost on friction, &c., when the engine is in actual use, although it may be valuable for comparing the workmanship of engines; the real co-efficient of friction for a prime mover when performing work can only be determined by measuring the power transmitted through the driving shaft, and subtracting this from the total force exerted.

Inequality of lubrication is another cause of variation in friction, although with moderate attention this inequality may be confined between limits of small difference.

Construction of Machinery.

Under this head we shall consider the nature of the strains on the various forms of working parts which occur in machinery.

The first part of a steam engine which we have to determine the proportions of is the steam cylinder; to obtain the least amount of cooling surface, the stroke of the piston or space through which it moves in one direction, should be twice the internal diameter of the cylinder; in marine engines this rule cannot be put into practice on account of want of space.

The strain per sectional inch on the circumference of the cylinder may be determined by the formula given in a former section, or involving a constant with it we shall find the thickness in inches to be

$$= \frac{D\,p}{4000} + \tfrac{1}{2}$$

where D is the diameter of the cylinder and p the pressure in pounds per square inch.

The piston rod may be treated as a column flat at one end and rounded at the other; but the following simple formula will be found satisfactory in practice:

Let d = diameter of piston rod in inches.
D = diameter of cylinder.
p = pressure in pounds per square inch.

$$\sqrt{\frac{D^2\,p}{2000}} = d$$

Another rule is to make the diameter of the piston rod $\frac{1}{10}$ of that of the cylinder. If the engine is of the beam class, the length of the beam should equal three times the stroke, and the depth of the beam should be half the stroke; it is usually of the section shown at Fig. 32.

Fig. 32.

a a is the centre line of the gudgeon on which the beam oscillates. The moment of strain will be equal to the total pressure on the piston, multiplied by the distance of its axis from the axis of the beam, and the moment of resistance may be found by the formulæ given in the first section; the following formula will, however, be found more convenient for practical purposes,

P = total pressure in pounds on the piston.
l = distance from cylinder axis to that of beam.
d = depth of beam = half the stroke.
A = sectional area of beam at centre.

then

$$A = \frac{P\,l}{500\,d}$$

for beams of cast iron.

The formula will apply to half beam or grasshopper engines, in which case l represents the distance between the axis of the piston rod and connecting rod, and the result applies to the section over the connecting rod.

The connecting rod is usually round, larger at the middle than the ends, and of wrought iron for direct acting and marine engines; but for stationary beam engines it is usually of cast iron, the centre being X section, the ribs being largest at the centre; it may be treated as a column rounded at both ends.

Connecting links continually occur in all sorts of machinery; they are usually of wrought iron, and should be made sufficiently strong to prevent vibration; their sections vary according to position, &c.; but a circular section is usually adopted where there is sufficient space, as this form is equally strong in every direction.

It would be useless to lay down any rule for connecting rods in general, as so much depends upon the kind of motion which is to be transmitted; for steam engines it should be made somewhat stronger than the piston rod.

In all cases where working parts are subject to percussive action, they must be of greater strength than otherwise, as this motion is one of the most destructive.

The thickness of the air pump is given by the formula,

$$\frac{D}{266} + \frac{1}{2} = \text{thickness in inches,}$$

where D = the external diameter; and for the condenser,

$$\frac{D}{266} = \text{thickness in inches.}$$

The air-pump rod may be $\frac{1}{10}$ the diameter of the air pump. The crank, or main driving shafts of engines, are usually constructed of wrought iron; the radius of the shaft at the journal or smallest part is given by the formula,

$$r = \sqrt[3]{\frac{40\,HP}{R}}$$

where,
r = radius of shaft in inches.
H P = horse-power of engine.
R = number of revolutions per minute of crank shaft.

For wrought iron shafts in general, subject to a twisting strain, the moment of resistance is represented by,

$$1570 \,.\, r^3$$

and the moment of strain should never exceed this; the moment of strain is found by multiplying the force in pounds by the leverage with which it acts, therefore, let

F = force in pounds.
l = leverage with which it acts.

$$F\,l = 1570 \,.\, r^3$$

$$\therefore r = \sqrt[3]{\frac{F\,l}{1570}}$$

The governor which is applied most frequently to stationary engines is of the form shown in Fig. 33, its object being to render the speed of the engine nearly uniform; $a\,d$ is a spindle, to the top of which are joined the rods $a\,b$, $a\,c$, which carry heavy spheres at their lower extremities; the rods $c\,d$, $b\,d$ are joined at b, and c to the governor arms, and at d to a collar easily movable up or down the spindle $a\,d$; the spindle $a\,d$ is connected with some revolving part of the engine.

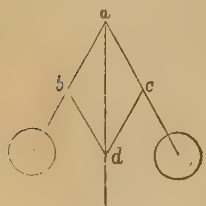


FIG. 33.

When the governor commences revolving, the centrifugal force of the spheres causes them to separate revolving round the centre a; the greater the speed is the greater will be the distance between the spheres, and *vice versa*; but in revolving round the centre a, the spheres either raise or lower the collar d, which, by proper machinery, opens or closes a valve in the steam pipe, thereby regulating the speed of the engine.

We will now consider the proportions of the governor. Let $a\,b$ (Fig. 34) represent a portion of the governor spindle, $a\,c$ one arm, carrying a heavy sphere at c, w the weight of that sphere, $c\,b$ the distance of the centre of the sphere from $a\,b$, or the radius of the circle in which the centre of the sphere revolves.

FIG. 34.

Let also, $a\,b = h$
$c\,b = r$
f = centrifugal force of the sphere.
v = velocity of sphere in feet per second.
$\frac{1}{2}g$ = 16·091, distance through which a heavy body falls in one second.
R = revolutions of governors per second.

It is evident that when the governor is in motion there are two forces acting upon the sphere, the centrifugal force tending to move it outwards, and the action of gravity tending to move it inwards; but if the sphere does not alter its plane of revolution, the moments of these forces round the centre a must be equal, so that they exactly balance each other; therefore, supposing the plane of revolution constant,

$$f\,h = w\,r$$

as the forces f and w act round a, with the leverages h and r, but the principles of dynamics show that

$$f = \frac{w\,v^2}{r\,g}$$

therefore,

$$h = \frac{r^2\,g}{v^2}$$

but,

$$r = \frac{v}{2\,\pi\,R}$$

therefore,

$$h = \frac{g}{4\,\pi^2\,R^2}$$

and replacing g and π by their numerical values, and calling N the number of revolutions per minute,

$$h = \left(\frac{54}{N}\right)^2$$

which gives the height in feet, the value of h in inches will be,

$$= \left(\frac{188}{N}\right)^2$$

and,

$$N = \frac{186}{\sqrt{h}}$$

The speed at which the engine is to work being known, and the speed of the governors found by consideration of the gearing connecting it with the engine, we can find the proper height from the above formula; or, if we have a governor we wish to apply to an engine, we can calculate the number of revolutions which is requisite for satisfactory action, and arrange the driving gear accordingly.

There are many other forms of governors, but as they are not very frequently used, we shall not investigate the principles of their action.

There are other parts of the steam engine, as slide rods, &c., which, being subject to scarcely any strain, are merely made strong enough to prevent vibration or sagging.

It is unnecessary, as a rule, to use formulæ in the designing of small machinery in general, as the proportions of the various parts may, after a little experience, be readily determined, although in very large or heavy machinery a due consideration of the principles of practical mathematics may secure a considerable economy of material and labour.

The forms proposed for the teeth of wheels are various, but the form most generally used approaches very near the epicycloid; we shall not consider this subject at length, but merely give the proportions which are found most convenient in practice.

The following dimensions are for plain spur or cog wheels:—

Length of teeth	$\frac{5}{9}$ of the pitch.
Length of teeth with clearance	$\frac{5}{7}$ „ „
Thickness of teeth	$\frac{4}{9}$ „ „
Breadth of teeth	$2\frac{1}{2}$ times „
Thickness of rim of spur wheel	$\frac{4}{9}$ of the pitch.
Thickness of rib inside rim of spur wheel ...	$\frac{4}{9}$ „ „
Thickness of flat arms	$\frac{4}{9}$ „ „

Bands are preferable to spur gearing wherever they can be conveniently applied, on account of the ease with which they work.

The fly wheel is a very important element of machinery; it is used wherever either the power applied or the work to be done is not uniform, thus in the steam engine the moment of force round the main shaft varies, and in machines whose action is intermittent the velocity would be greatly accelerated during the intervals of action; the speed is retained between any desired limits by means of a heavy wheel, which absorbs the excess of force, and yields it up to the machinery as the motive power diminishes; the heavier the wheel is, and the greater its radius, the more uniform will the motion of the machine be.

Let C (Fig. 35) represent the axis of the crank shaft, C D the crank arm, D e connecting rod, P a constant pressure applied to C D through the connecting rod, and P_1 a constant resistance.

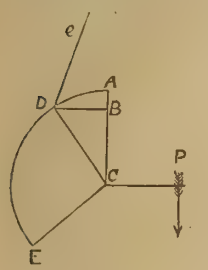


FIG. 35.

Let the

$$A\,C\,D = \alpha$$
$$C\,D = r$$
$$C\,P_1 = r_1$$

The work done upon the crank while it describes the angle α

$$= P \,.\, \overline{A\,B} \text{ or } P\,r \text{ vers. } \alpha$$

and the resistance is overcome through an arc subtended by the angle α, but with a radius $= r_1$, therefore the work done by the resistance

$$= P_1\, r_1\, \alpha$$

and the excess of work done by the moving power over the resistance

$$= P \,.\, r \,.\, \text{vers. } \alpha - P_1\, r_1\, \alpha \ldots\ldots\ldots\ldots \quad (1)$$

$2\,r\,P$ represents the work done by the moving power during one stroke of the piston, and $2\,P_1\,r_1\,\pi$ the work expended on the resistance during one revolution of the fly wheel; let s represent the number of strokes of the piston during one revolution of the fly wheel, then, if the engine have attained a uniform motion,

$$2\,s\,r\,P = 2\,P_1\,r_1\,\pi$$

$$\therefore r_1\,P_1 = \frac{s\,r\,P}{\pi} \ldots\ldots\ldots\ldots \quad (2)$$

substituting in equation (1)

$$P \,.\, r \,.\, \text{vers. } \alpha - P \,.\, r \,.\, \frac{s\,\alpha}{\pi}$$

therefore the excess of work done by the power over the resistance

$$= P\,r \left\{ \text{vers. } \alpha - \frac{s\,\alpha}{\pi} \right\} \ldots\ldots \quad (3)$$

But this excess is equal to the work which has accumulated in the moving parts of the machine while the crank described the angle α; we will suppose it to have been entirely absorbed by the fly wheel.

If I represents the moment of inertia of the wheel, w the weight of a cubic foot of its material, v its angular velocity when the crank was in the position C A, and v its angular velocity when it had passed to C D, then the work accumulated between these positions,

$$= \frac{I\,w}{2\,g} \left(v^2 - v_1^2 \right)$$

therefore,

$$\frac{I\,w}{2\,g} \left(v^2 - v_1^2 \right) = P \,.\, r \,.\, \left\{ \text{vers. } \alpha - \frac{s\,\alpha}{\pi} \right\}$$

$$\therefore v^2 - v_1^2 = \frac{2\,P \,.\, r \,.\, g}{I\,w} \left\{ \text{vers. } \alpha - \frac{s\,\alpha}{\pi} \right\} \ldots \quad (4)$$

We will now proceed to find the greatest variation of velocity. If the engine has attained an uniform motion, the angular velocity of the fly wheel will be of the same value whenever the wheel returns to the same position, so that v_1 is constant, and v is a function of α.

The value of v assumes its minimum value when

$$\frac{d\,v^2}{d\,\alpha} = d \text{ and } \frac{d^2\,v^2}{d\,\alpha^2} > 0$$

and its maximum when,

$$\frac{d\,v^2}{d\,\alpha} = o \text{ and } \frac{d^2\,v^2}{d\,\alpha} < 0$$

But

$$\frac{d\,v^2}{d\,\alpha} = \text{sin. } \alpha - \frac{s}{\pi} \text{ and } \frac{d^2\,v^2}{d\,\alpha} = \text{cos. } \alpha$$

therefore when

$$\frac{d\,v^2}{d\,\alpha} = 0$$

$$\text{sin. } \alpha = \frac{s}{\pi} \ldots\ldots\ldots\ldots \quad (5)$$

This equation will be satisfied by two values of α, one of which is a supplement to the other, so that if β represent one, $\pi\,\beta$ will represent the other; which will give opposite signs to the value cos. α, one being positive and the other negative; one value, therefore, corresponds to a minimum and the other to a maximum angular velocity.

If we make the angle A C D such that its sine is equal to $\frac{s}{\pi}$ the position C D will be that which corresponds to the minimum velocity of the fly wheel, and if we make the angle A C E a supplement to A C D, the position C E will correspond to the maximum velocity of the fly wheel.

Let v_1 represent the least angular velocity of the fly wheel, and v_2 the greatest; then the work accumulated in the fly wheel between C D and C E

$$= \frac{I\,w}{2\,g} \left(v_2^2 - v_1^2 \right)$$

and the same value is represented by equation 3, if we substitute the values β and $\pi - \beta$ for α, therefore,

$$\frac{I\,w}{2\,g} \left(v_2^2 - v_1^2 \right) = P \,.\, r \,.\, \left\{ 2 \text{ cos. } \beta - s \left(1 - \frac{2\,\beta}{\pi} \right) \right\}$$

$$\therefore v_2^2 - v_1^2 = \frac{2\,P \,.\, r \,.\, g}{I\,w} \left\{ 2 \text{ cos. } \beta - s \left(1 - \frac{2\,\beta}{\pi} \right) \right\} \quad (6)$$

which is the greatest variation of velocity, the sine of β being $\frac{s}{\pi}$

We will now apply these formulæ to the case of a double-acting engine, having the fly wheel fixed on the crank shaft.

Let $\frac{N}{2}$ represent the mean number of revolutions per minute, then $\frac{N}{120}$ will represent the mean number of revolutions per second, and $\frac{N\,\pi}{60}$ the mean angular velocity of a particle in the wheel at a distance from the axis equal to unity.

Let the fly wheel be of such dimensions that its angular velocity will not deviate more than $\frac{1}{n}$ from its mean velocity, so that,

$$v_2 = \frac{N\,\pi}{60} \left(1 + \frac{1}{n} \right)$$

and

$$v_1 = \frac{N\,\pi}{60} \left(1 - \frac{1}{n} \right)$$

then

$$v_2^2 - v_1^2 = \left(v_2 - v_1 \right) \left(v_2 + v_1 \right) = \frac{N^2\,\pi^2}{30^2\,n}$$

substituting in equation 6

$$\frac{N^2\,\pi^2}{30^2\,n} = \frac{2\,P \,.\, r \,.\, g \,.}{I\,w} \left\{ 2 \text{ cos. } \beta - s \left(1 - \frac{2\,\beta}{\pi} \right) \right\}$$

Let H represent the horse power of the engine, then the units of work done per minute on the piston

$$= 33{,}000 \text{ H},$$

But $\frac{1}{2}$ N s is the number of strokes per minute, and 2 P . r . is the work done on the piston per stroke, therefore

$$33{,}000 \text{ H} = \tfrac{1}{2}\,N \,.\, s \,.\, 2\,P \,.\, r$$

$$\therefore 2\,P \,.\, r = \frac{66{,}000 \text{ H}}{N \,.\, s \,.}$$

substituting this in the above equation,

$$I\,w = \left\{ \frac{66{,}000 \,.\, 30^2\,g}{\pi^2} \right\} \left\{ 2 \text{ cos. } \beta - s \left(1 - \frac{2\,\beta}{\pi} \right) \right\} \frac{H\,n}{N^2\,s}$$

If k represents the radius of gyration of the wheel and M its volume,

$$M\,k^2 = I$$

$$\therefore w\,M\,k^2 = I\,w$$

but w M represents the weight of the wheel in lbs.; let W be its weight in tons, then

$$M\,w = 2240 \text{ W}$$

substituting this value and solving for W, we have

$$W = \left\{ \frac{66{,}000 \cdot 30^2 g}{\pi^2} \right\} 2 \cos.\ \beta - s \left(1 - \frac{2\beta}{\pi} \right) \Big\} \frac{H\,n}{N^3\,s\,k^2}$$

and substituting the values of π, g, β, and s which last $= 2$, also making $\sin.\ \beta = \frac{s}{\pi} = 0{\cdot}6366$, $\cos.\ \beta$ being $= 0{\cdot}7712$, and $\frac{\beta}{\pi} = 0{\cdot}2196$, we have

$$W = 18{,}192 \frac{H\,n}{N^3\,k^2} \quad \ldots\ldots\ldots\ldots \quad (7)$$

the accumulated work being considered as absorbed by the periphery of the wheel.

If t represents the difference between the external and internal radii of the rim, R the mean radius, and b the breadth

$$M\,k^2 = I = 2\,\pi\,b\,t\,R \left\{ R^2 + \frac{t^2}{4} \right\}$$

but by Guldinas's first property,

$$2\,\pi\,b\,t\,R = M$$

therefore

$$k = \left\{ R^2 + \frac{t^2}{4} \right\}$$

substituting in equation 7

$$W = 18{,}192 \frac{H\,n}{N^3 \left(R^2 + \frac{t^2}{4} \right)}$$

but as the depth of the rim t is usually small compared with the mean radius R_1 $\frac{t^2}{4}$ may be neglected as compared with R^2, when the equation will become

$$W = 18{,}192 \frac{H\,n}{N^3\,R^2} \quad \ldots\ldots\ldots\ldots \quad (8)$$

For ordinary work in practice $\frac{1}{30}$ is allowed as the value of $\frac{1}{n}$ and for work which requires very uniform motion $\frac{1}{60}$; replacing n in the above formula, by these values we obtain

$$W = 545{,}760 \frac{H}{N^3\,R^2}$$

$$R = \sqrt{545{,}760 \frac{H}{W\,N^3}}$$

when

$$\frac{1}{n} = \frac{1}{30}, \text{ and}$$

$$W = 1{,}091{,}520 \frac{H}{N^3\,R^2}$$

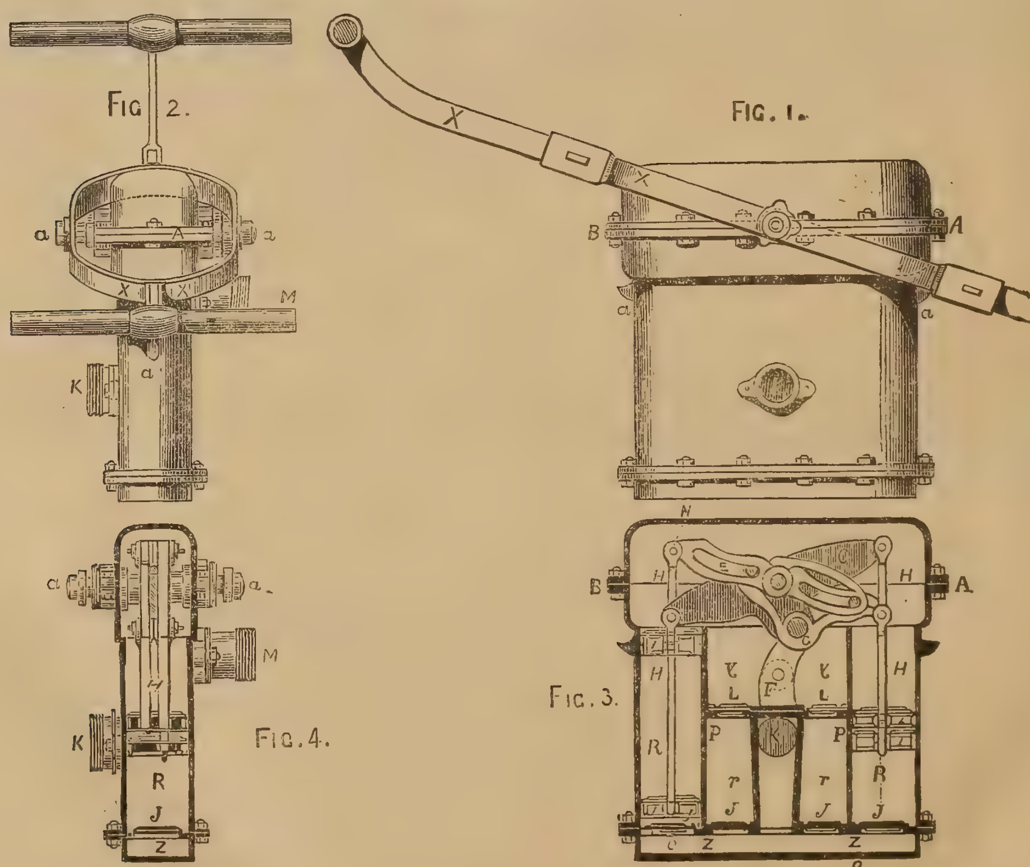
$$R = \sqrt{1{,}091{,}520 \frac{H}{W\,N^3}}$$

when

$$\frac{1}{n} = \frac{1}{60}$$

In these formulæ all dimensions are in feet.

From the foregoing equations others may readily be deduced giving the value of W, for other cases, as in various kinds of machinery, etc.

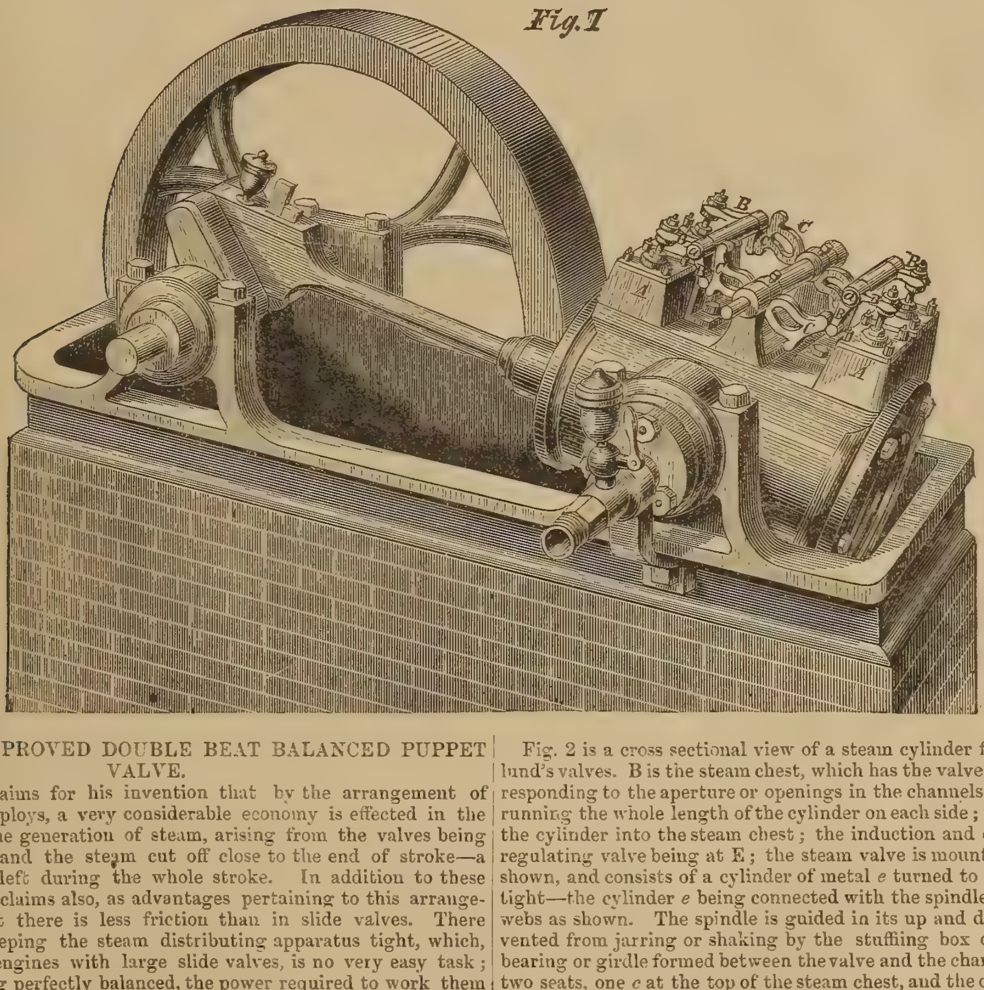


GRAHAM'S PATENT DOUBLE-ACTING FORCE OR LIFT PUMP FOR SHIPS, FIRE ENGINES, ETC.

In THE ARTIZAN of September we referred to the very satisfactory performance of these pumps in discharging the water from the iron ship *Ganges;* and as some correspondents have since asked us for further information as to the constructive details, &c., we have now the pleasure of presenting our readers with the accompanying woodcut illustrations of the pumps in question.

Fig. 1 represents an elevation of a pump complete, and shows the stops *a a* for the handles or levers, a portion of one of which is broken off in this view. Fig. 2 is an end elevation of the pump looking towards the end A in fig. 1. Figure 3 is a vertical section taken through both of the chambers of the pump, showing the working parts of it; and fig. 4 is a vertical section taken through one of the chambers, and on the line N O, fig. 3. A driving lever X X, made double in the middle, is fixed at its centre on the centre shaft A, and at each end of it is fixed a handle, as shown in fig. 2. The beam C is also fixed upon the shaft A in the same direction as the driving lever X X, so that when the driving lever X X is moved, the beam C shall have similar motion given to it. C is a tumbling lever, with a stud pin at the end of each of its arms, and on these stud pins are mounted friction rollers. The tumbling lever is mounted, and rocks upon the centre shaft A, and the rollers at the ends of its arms move in a segment of a circle, and in two slots in the beam E. The working parts of the pump are all enclosed in a water-tight case, having an inlet for the water at K, and an outlet at M. On the under side of the beam C, and at its centre, is fixed an arm, and at the end of that arm is a stud pin, carrying a friction roller, which works in a short vertical slot in the tumbling lever, so as to give motion to that lever when the beam C is moved. The friction rollers at the ends of the arms of the tumbling lever work in the slots of the beam E E, so as to cause that beam to rock on the centre shaft A, in a direction the reverse of the beam C; H H H H are the spears or rods of the buckets or plungers; I I I I are the buckets; and J J J J are the suction or foot valves; K is the suction nozzle, to which is to be attached a suction pipe, through which the water is to be drawn into the machine; the water upon being drawn through the inlet K passes down into the space Z Z, under the valves J J J J, and is from thence drawn into the working chambers R and auxiliary chambers *r r*; L L are escape or delivery valves, through which the water is forced into the reservoir Y Y by the action of the lower buckets, when the water passes from the working chambers through the orifices *p p*, into the auxiliary chambers *r r*, and so through the valves L L. The water raised by the upper buckets passes over the tops of the working chambers into the reservoir Y Y, and the water passes out of the machine at the nozzle or opening M, to which a pipe may be attached in order to force the water, and convey it to the place of its destination.

Fig. I



WESTLUND'S IMPROVED DOUBLE BEAT BALANCED PUPPET VALVE.

Mr. Westlund claims for his invention that by the arrangement of valves which he employs, a very considerable economy is effected in the fuel consumed for the generation of steam, arising from the valves being perfectly balanced, and the steam cut off close to the end of stroke—a free exhaust being left during the whole stroke. In addition to these points, the inventor claims also, as advantages pertaining to this arrangement of valves that there is less friction than in slide valves. There is no difficulty in keeping the steam distributing apparatus tight, which, in heavily powered engines with large slide valves, is no very easy task; and, the valves being perfectly balanced, the power required to work them is very trifling, as compared with ordinary slide valves.

We understand that engines up to 100 horse power fitted with these valves have now for some time back been at work, and are found in practice to effect a very considerable economy in the consumption of fuel.

Our illustration, Fig. 1 shows the improvement adapted to an oscillating engine in which the valve chests, A, are placed on the top of the cylinder, and the valves are elevated and allowed to drop by their own weight, by angle levers, B, moving on centres *a*. These angle levers are operated by cams, C, which are braced to the framing of the engine and remain stationary while the cylinder oscillates, and as it carries the angle levers with it, it causes them to move against the cams and so receive their motion. An oscillating engine which had this valve attached has, we understand, been worked up to 400 revolutions a minute, and there does not seem to be any limit to the speed at which Mr. Westlund's valve can run.

Fig. 2 is a cross sectional view of a steam cylinder fitted with Mr. Westlund's valves. B is the steam chest, which has the valve openings exactly corresponding to the aperture or openings in the channels or steam passages C, running the whole length of the cylinder on each side; *b* is the opening from the cylinder into the steam chest; the induction and exhaust passages and regulating valve being at E; the steam valve is mounted on the spindles as shown, and consists of a cylinder of metal *e* turned to fit its bearings steam tight—the cylinder *e* being connected with the spindle by means of arms or webs as shown. The spindle is guided in its up and down motion and prevented from jarring or shaking by the stuffing box on top, and a bottom bearing or girdle formed between the valve and the channel C. The valve has two seats, one *c* at the top of the steam chest, and the other *d* at the bottom.

Steam might be taken in through both seats; but, as the area of the lower opening is always large enough, there is no necessity to take it in through more than the bottom seat. From this cause, the motion of these valves need only be about one-fourth of the ordinary puppet valve; and by this means they are enabled to be opened and closed with more rapidity, and consequently, a greater advantage than usual can be taken of the expansion of the valve. The exhaust valve D^1 is, as will be seen, constructed precisely similar to the steam valve D.

Fig. 3 is the diagram of the face of a steam cylinder showing the steam chest, valve openings, steam passages, and the course of the steam, B is the division or compartment in the steam passage E; the steam enters by the passage C. A is the valve opening from the passage E. F is the inlet or aperture through which the steam passes to the cylinder upon the steam valve A, being opened; the steam having operated upon the piston, the

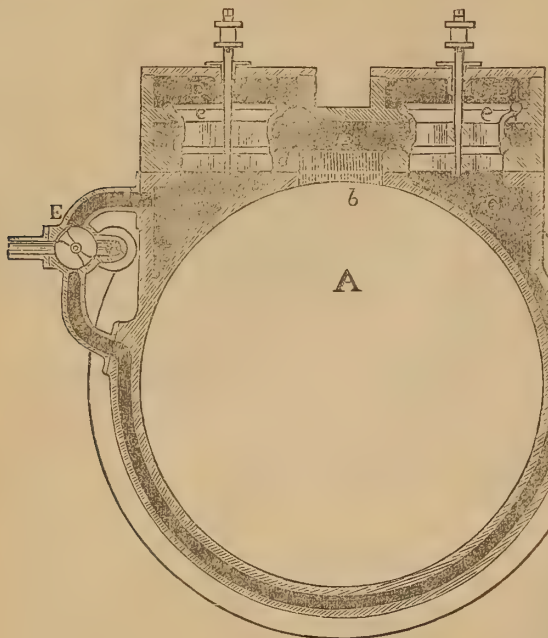


Fig. 2.

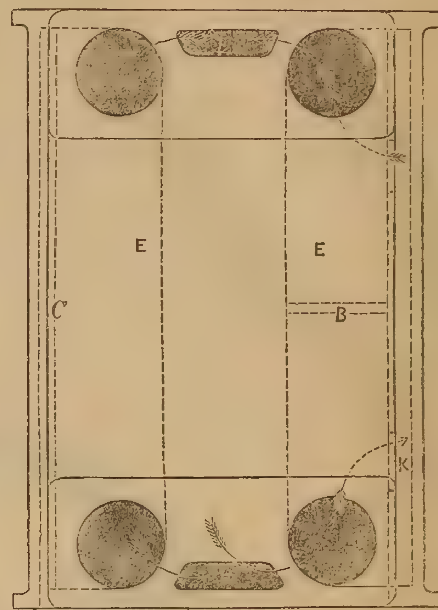


Fig. 3.

exhaust valves *g g* are opened, the steam enters again through the aperture H from below the piston. After which the valve I is opened and the waste steam is led to the condenser through the exhaust passage K.

We may add that this arrangement of valves was described and illustrated in the *Scientific American* in 1859, previous to which the inventor had, at the request of the United States Government, furnished them with models and drawings of marine engines, fitted in accordance with his invention.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Cambridge Meeting, 1862.

SECTION G.—MECHANICAL SCIENCE.

Thursday, October 9.

The President, Dr. W. Fairbairn, opened the proceedings of the Section with an address in which, after briefly alluding to the great advance made in the application of science to the useful arts during the last fifty years, he proceeded to advert to the progress and position of mechanical science as shown in the International Exhibition. A very casual glance at this exhibition, as compared with those of 1851 and 1855, shows with what energy the public mind has been at work; and though there is no new discovery of importance in mechanical science, yet the machines are more compact and better executed than at any previous exhibition, and a great deal is to be seen of a character both interesting and instructive. In land steam-engines, the horizontal is rapidly supplanting the beam or vertical engine, and is applied not only with efficiency to manufacturing, but also to agricultural purposes. In marine engines we are without rivals: we find in them beauty of execution, compact form and colossal dimensions, combined with a simplicity, concentration of power and precision of action never before equalled in this or any other country; and it must be a source of pride that this country, the first maritime nation in the world, should stand pre-eminently first as the leader of naval propulsion. In locomotives, if we are not in advance of other countries, we are not behind them; though both France and Germany exhibit splendid specimens of engines. There is, however, in this country a greater simplicity of construction, greater compactness of form, and clearer conceptions in working out the details. With regard to machines, and tools, the creators of machines, at no period before has such an exhibition been seen. Some of the tools, such as the turning, planing, boring, and slotting machines, are of a very high order; and the tool machines for the manufacture of fire-arms, shells, rockets, &c., are of such a character as to render all the operations, however minute, perfectly automatic, with an accuracy of repetition that leaves the finished articles identical with every other article from the same machine. Such, indeed, is the perfection of the tool system, that in almost every case we may calculate on no deviation beyond the one-thousandth of an inch. The speaker then proceeded to notice the spool machine for winding sewing-thread on bobbins, the paper-bag-making machine, and the riband saw machine. He then adverted to the changes in the construction of ordnance, and in the art of defence. For a time it was considered that ships plated with iron 4½in. thick were invulnerable to shot or shell; and this opinion was acted upon in this country, in France, and in America. Our Government experiments have to a great extent dispelled these notions. It has been proved that a smooth-bore Armstrong gun with a 150lb. spherical shot can pierce a 4½in. plate and 18in. of teak. In fact, it has been proved by experiments that no vessel yet constructed is able to carry armour-plates of sufficient thickness to resist such powerful ordnance as has been brought against it. The best description of iron has been sought for and obtained, and the balance of power had, however, remained in favour of the gun,—but with this qualification, that the gun had to sustain an explosive force of powder equivalent to one-third the weight of the shot—a charge which the gun was unable to bear. Under ordinary circumstances, with the usual charge of one-eighth the weight of the shot, it might be reasonably inferred that the balance of strength was on the side of the plate, and the guns of such heavy calibre were insufficient in strength to sustain these enormous charges of powder. The results, too, had only been produced by these heavy charges at short distances. It was determined to try the effect of the Horsfall gun, 22 tons weight, with a charge of 75lbs. of powder and a 300lbs. shot, against the *Warrior* target of 4½ iron and 18in. teak: the result was, the penetration of the mass with a huge opening into the target of upwards of 2ft. in diameter. This experiment would not apply to ships of war, which could not carry ordnance of such immense weight, but was applicable to the case of forts, from which an enemy's ship might be struck at the distance of 1000 yards. Passing from the Horsfall gun, Mr. Fairbairn related the late experiments with the Whitworth gun. There had been very early established the distinction between the penetrating powers of solid shot and shell, the shell invariably failing to penetrate even a moderately thick plate of iron, and it was concluded that a comparatively thin plate was a sufficient defence against it: 2½in., and even 2in., were considered a sufficient thickness. The late experiment with a Whitworth gun and flat-fronted hardened shells had, however, dispelled these notions. The 12-pounder at 200 yards sent these shells through a 2-inch plate backed with a foot of timber. It had been suggested that a more powerful armour might be constructed by dividing the armour into plates, each of 2 inches thickness, and these plates separated by a certain space; the theory being that, though the first might be pierced, yet the force of the shell would be so deadened that the second plate would stop it. The Whitworth 70-pounder was tried against a target on this principle. A strong oak frame, armed with a 4-inch plate, was attached to a second plate of 2 inches thick, an interval of two or three feet being left between them. The shell with only 12 lb. of powder pierced the outer side of the target completely, oak and iron together, after which it burst inside the frame and shattered it to pieces. From this it was clear that 4 inches of solid iron and 9 inches of wood were no protection against such a gun, and that no gun-boat, such as those on the American waters, was proof against such a weapon. In point of fact, Mr. Whitworth, with a rifled gun lighter than a 68-pounder, could destroy them with his steel-hardened shells at a distance of 1500 or 2000 yards. A further experiment with a larger Whitworth gun, a 120-pounder, at a distance of 600 yards, proved that the sides of the *Warrior* are no longer shell proof. A 130lb. solid shot, with a charge of 23lb. of powder, went through the 4½-inch plate, and lodged in the wood behind it. A shell of the same weight, with a charge of 25lbs. of powder, penetrated the armour-plate and exploded, tearing the wood backing, and lodging in the opposite side. From these experiments Mr. Fairbairn inferred that the victory is on the side of the gun, and that it may be difficult, under such powerful odds, to construct ships of sufficient power to prevent their destruction by the entrance of shells.

Mr. J. Nasmyth then described his "Improved Form of Link Motion." There were many contrivances for effecting the same purpose as the "link" motion; but the latter, the invention of a mechanic in the employ of the Stephensons, had superseded all others. Mr. Nasmyth showed how, by his modification of it, a greater simplicity of construction was obtained, and a greater freedom from the evils which the wear and tear of the ordinary link motion produced. He had invented it in 1852, but it was little known. It had, however, been adopted with great success by Mr. Humphreys. It would be seen on the engine exhibited by that gentleman in the International Exhibition.

Mr. E. E. Allen read a paper "On the importance of Economising Fuel in iron-plated Ships,"—which is given at length, and illustrated at p. 253.

Dr. F. Grimaldi read a paper descriptive of a New Marine Boiler. which will be given in an early number.

Mr. W. Thorold then read a paper "On the Failure of the Sluice in Fens, and on the means of securing such Sluices against a similar Contingency." The author described the circumstances attending the failure of the sluice, and pointed out that, in his opinion, the mode of preventing such an accident in future was the employment of double sluices, one behind the other, the water between the two being always kept locked in, at a mean height between the water in the drain and that on the sea-side.

The discussion was adjourned till Monday, in order that the members should have an opportunity of previously seeing the place, to which an excursion would be made on Saturday.

FRIDAY, OCTOBER 10.

Mr. J. Oldham read the report of the Committee appointed last year to make "Tidal Observations in the Humber." The observations were made at three places: New Holland, Hull Victoria Docks, and at Goole Docks. They were taken every five minutes at New Holland and at Goole, and every fifteen minutes at Hull Docks. The observations comprised 55 tides, and were taken at a period when little or no wind occurred to disturb the ordinary rise and fall. The results were carefully tabulated and presented to the Section. These observations fully bore out the statement made by Mr. Oldham at the Manchester Meeting of the Association, that at Hull, for three hours after the tide has attained to the 16ft. mark, there is no more rise.

"On the Strains in the Interior of Beams and Tubular Bridges," by the Astronomer Royal.—The Astronomer Royal, after briefly adverting to the circumstance that he now addressed the Section in the same place in which more than thirty years previously he was accustomed (as Plumian Professor) to deliver lectures, sometimes on subjects analogous to this now before them, proceeded with the subject nearly in the following order. He had often desired to know (as probably many members of the Section had desired) what were the directions and magnitudes of the crumpling or stretching actions in the sides of our great tubular bridges, and had referred to several books on related subjects, but derived no assistance from them. After several attempts, he had at length succeeded in constructing a satisfactory theory. It was first necessary to acquire an idea of the measure of compressing or tensile forces in planes (the whole investigation, as regarded bridges, being confined to their planes), and this would be the length of the ribbon of metal whose weight acting on any limited space would produce the compression or tension sustained by that limited space. Next, it was necessary to find according to what law the effect of the force varies when its direction varies (as, for instance, what is the tendency to tear open a fissure, if the direction of a tensile force rotates in the plane of the metal); and he found it proportional to the square of the cosine of the angle which the direction of the force makes with the normal to the line sustaining the action. Using this fundamental theorem, he was able to show that the most complicated combination of forces might be reduced to the combination of two forces at right angles to each other; both forces being compressive, or both tensile, or one compressive and the other tensile. The problem, therefore, in any given case of a beam, would be, to find the magnitude of two forces and the direction of one (three elements in all), at every point of the beam. Conceive, then, a beam to be divided (optically, not mechanically) into two parts, by a curved line in its vertical plane, extending from the lower to the upper edge, and consider the equilibrium of the more advanced part of the beam. The forces which act on it are—the compressing or tensile forces acting over the imaginary curved line, the weight of the different portions of the more advanced part of the beam, and the reaction of supports in that part of the beam. It is soon found that the symbols for the three elements above mentioned become combined in forms which render it convenient to use three new symbols for their combinations, including also the weight of the advanced part of the beam. Putting L, M, O, for these symbols, R for a vertical reaction at the distance h in the direction of x (x horizontal), the three equations of equilibrium are,—

$$\text{(Equation for forces in } x\text{)}, \int dx\,(\mathrm{L}\,p + \mathrm{M}) = o;$$

$$\text{(Equation for forces in } y\text{)}, \int d\,x\,(\mathrm{M}\,p + \mathrm{O}) - \mathrm{R} = o;$$

$$\text{(Equation of momenta)}, \int d\,x \left\{ y\,(\mathrm{L}\,p + \mathrm{M}) + x\,(\mathrm{M}\,p + \mathrm{O}) \right\} - \mathrm{R}\,h = o : p \text{ being put for } \frac{d\,y}{d\,x}.$$

—The equations in this form are somewhat unmanageable, but the following fortunate idea removed all difficulty:—Since the equations are true for any curve, and are, therefore, true (*mutatis mutandis*) for any curve near another, the difference in the equations produced by stepping from one curve to another will be $= o$. This is evidently a case for application of the process of the Calculus of Variations. On applying it, the first equation gives

$$\frac{d\,\mathrm{M}}{d\,y} - \frac{d\,\mathrm{L}}{d\,x} = o; \text{ the second gives } \frac{d\,\mathrm{O}}{d\,y} - \frac{d\,\mathrm{M}}{d\,x} = o:$$

the third gives an equation, then identically true. From this it follows immediately that the three quantities, L, M, O, may be thus represented, in terms of one function, F, of x and y, and of arbitrary functions, ϕ and ψ;

$$\mathrm{L} = \frac{d^2\,\mathrm{F}}{d\,y^2} + \phi\,(y),\ \mathrm{M} = \frac{d^2\,\mathrm{F}}{d\,x\,d\,y},\ \mathrm{O} = \frac{d^2\,\mathrm{F}}{d\,x^2} + \psi\,(x).$$

Now, suppose F is so chosen that the equations may be satisfied without $\phi\,(y)$ and $\psi\,(x)$; then it is evident that $\phi\,(y)$ and $\psi\,(x)$ will satisfy the equations without their last constant terms; they may, therefore, be multiplied or aggregated in any degree; and upon viewing the way in which they enter into the equations, they are simple forces—one in the direction of x, and the other in the direction of y. It is plain, therefore, that these are accidental forces in the interior of the metal, such as are produced by injudicious casting of fusible metal or injudicious union of malleable metal; they are not subjects for present contemplation, and are to be omitted. Omitting them, and substituting the simpler expressions for L, M, O, in the equations, every part becomes integrable *per se*; and the integrated equations become the following (in which the valves for the first part of the curve, where $x = z$, $y = o$, are to be subtracted from those for the extremity of the curve at the upper corner of the end of the beam, where

$$x = 2\,r, y = s): \frac{d\,\mathrm{F}}{d\,y} = o, \frac{d\,\mathrm{F}}{d\,x} = \mathrm{R}, y\frac{d\,\mathrm{F}}{d\,x} + x\frac{d\,\mathrm{F}}{d\,x} - \mathrm{F} = \mathrm{R}\,h:$$

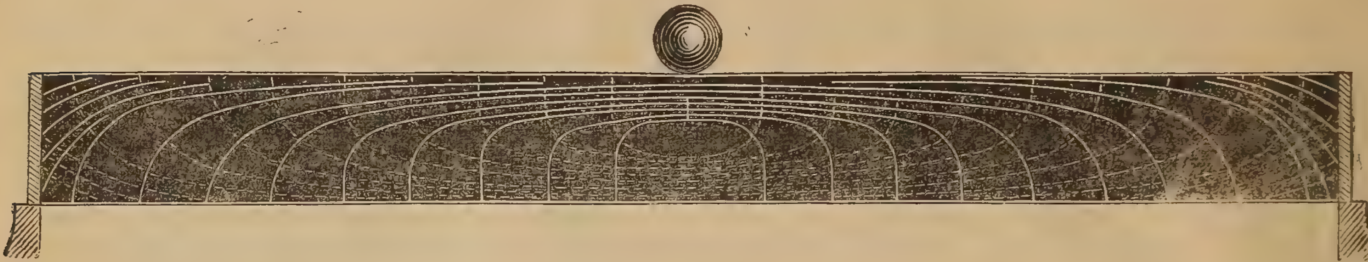
equations of remarkable simplicity. Various considerations show that the expressions for the forces will contain only integral powers of x and y Assuming, then, a form for F, with indeterminate co-efficients, several relations are given by these equations. Still it is necessary to find other considerations, in each special case, which will produce due limitation of the extreme generality of form. For this purpose reference is made to the theorems of ordinary mechanics, by which, in the case of a strained elastic beam, the horizontal disruptive force is found. This force is the equivalent of

$$-\,\mathrm{L} \text{ or } -\frac{d^2\,\mathrm{F}}{dy^2}.$$

This consideration in every case is sufficient; it being always necessary to ascertain that the three equations are satisfied. F being thus completely determined, and L, M, O, being found, the original three elements (two forces and the direction of one) are obtained numerically without difficulty. As a specimen of the forms assumed by F; in the instance of a beam whose length is $2r$ and depth s, supported on two piers,

$$\mathrm{F} = \frac{1}{2\,s^2}\,(x^2 - 2\,r\,x)\,(3\,s\,y^2\,2\,y\,-^3).$$

It was pointed out that the state of the end of the beam in this instance re-



[*Strains in the interior of a beam or tubular bridge, whose ends rest upon piers, and which supports, at the middle of its length, a weight equal to half the weight of the beam. The continuous curves indicate the direction of thrust or compression, and the interrupted curves or chain lines indicate the direction of pull or tension.*]

quired special consideration. In other vertical sections of the beam, a strain on one side is met by a nearly equal strain on the other side of the section; but at the end, though the forces are considerable, there is no antagonistic force. On resolving the forces it is found that the horizontal force = *o*; but the vertical force is considerable, being aggregated by successive vertical pressures from the top to the bottom, where this sum at last amounts to half the weight of the beam. This gives rise to the necessity, recognised by engineers, of inserting a strong vertical frame in the end of a tubular bridge. The Astronomer Royal then stated that he had applied the theory to the following cases:—1. a beam projecting from a wall; 2. a beam supported at both ends; 3. a beam supported at both ends, and carrying a weight on its centre; 4. a beam supported at both ends, and carrying an excentric weight; together with two others, to be mentioned shortly. Of the instance No. 3, he exhibited a large drawing (of which a reduced copy is given above, in which the strains and their directions had been computed for 231 points; and he called attention to the folllowing special distributions of force:—the great longitudinal strains near the centre of the beam's length, but not in the centre of its depth; and the considerable inclined strains near its ends, of which there is little trace in the middle; as also to the circumstance that at the middle of the beam's depth the forces make angles of 45° with the horizon, throughout; and sensibly the same angles at the end of the beam. The Astronomer Royal then referred to the remarkable contrivance adopted in the junction of the tubular segments of the Britannia Bridge, in which (by raising the distant end of one segment at the time of union), the junction was so effected as to strain the middle of each segment upwards, thereby doubling the strength of the bridge. He pointed out that this contrivance introduces an additional term in the third equation, expressing the addition of a moment. He had applied the theory completely to the two cases: 5, where such strains are impressed on both ends of a tube; 6, where such a strain is impressed on only one end of a tube. The lines of strain are very much changed. In No. 5, the inclined strains, which in Nos. 2 and 3 are at the ends, are now advanced towards the middle; and the ends, as well as the middle, are principally affected by longitudinal strains. It was then pointed out that all these conclusions depend on an assumed physical principle, of which Mr. W. H. Barlow's experiments appear to suggest a slight modification. The Astronomer Royal concluded by addressing himself to Members of the University present with the remark, that in problems like this, applying to constructive mechanics, as well as in those applying to the system of the world, examples might be found illustrating the beauty and the power of mathematics, at least equal to those suggested by the ingenuity of examiners, and possessing that dignity which attaches to reality of application.

This communication gave rise to several comments. Dr. Robinson stated that he had himself desired to investigate the subject mathematically, and had arrived at equations probably identical with those first found here, but had been unable to reduce them to a manageable form.

Professor Rankin had made some advance in the theory, and, in particular, had ascertained the law of aggregation of pressure in the end-frames, which the Astronomer Royal recognised as agreeing with his own. Professor Rankin considered that a great step had been gained in the present communication, in showing that all the pressures might be made to depend on one function, F.

Mr. Fairbairn gave an interesting account of the way in which experiments had been carried on in reference to the then future construction of the Britannia Bridge, the models being loaded till they broke down in different ways, and being then strengthened in those parts and again tried. He recognised the conclusions of the theory as agreeing precisely with the results of experiment.

Mr. Scott Russell also described the views which had guided him in planning the various parts of tubular bridges, which led to an according result.

On the suggestion of some members of the Section, that the lines of strain bear some relation to the lines of polarisation and dipolarisation produced by stained glass, the Master of Trinity remarked that this view had been suggested many years ago by Sir David Brewster, and that it had been partly illustrated by experiments made in this very lecture-room.

Professor D. T. Ansted, M.A., read a paper "On Artificial Stones." In this paper the author described the various materials and contrivances used for the purpose of replacing stone where natural stone could not be advantageously procured. He described, in succession, terra cottas, cements and siliceous stones, pointing out the character, properties, uses, advantages, and disadvantages of each. He alluded to experiments made in the laboratory on the various methods suggested for preserving stone by a section of the Committee, recently appointed by the Board of Works, in reference to the Palace of Westminster—Dr. Hoffman, Dr. Frankland, Mr. Abel, and the author, being members of it. During their investigations a remarkable material was submitted by Mr. Ransome for their consideration, and its discovery arose out of Ransome's method of preserving stone by effecting a deposit of silicate of lime within the substances of the absorbent stone, by saturating the surface with a solution of silicate of soda, and then applying a solution of chloride of calcium—thus producing a rapid double decomposition, leaving an insoluble silicate of lime within the stone, and a soluble chloride of sodium, which could afterwards be removed by washing. To prove this, Mr. Ransome made small blocks of sand in moulds, by means of silicate of soda, and then dipped them in chloride of calcium. The result was the formation, almost instantaneously, of a perfectly compact, hard, and, to all appearance, a perfectly durable solid. Mr. Ransome at once adopted the process for the formation of an artificial stone, which the author of the paper considered would combine the advantages and show some of the disadvantages of other artificial stones. Experience, however, can alone be the test of its durability. A specimen, weighing two tons, is shown in the International Exhibition, and the substance is used in the stations of the Metropolitan Railway. It is cheap, can be made on the spot of almost any rubbish or material, and of any form or size. Experiments made by Mr. Ransome show that, as compared with Portland stone or Caen stone, a bar with section 4in. square and 8in. long between supports, sustained 2122lbs. suspended midway between the supports, while similar bars of Portland and Caen stone broke respectively with 750lbs. and 780lbs. The adhesion of the stone is shown by weights suspended from a piece prepared to expose a sectional area of $5\frac{1}{4}$in. Caen stone separated at 768lbs.; Bath, at 796lbs.; Portland, at 1104lbs.; Elland Edge, at 1874lbs.; Ransome's, at 1980lbs. A cube of 4in. sustained 30 tons. Mr. Ransome showed the process to the Section by making several pieces in the presence of the members, and the process was also exhibited afterwards at the *soirée* in the Guildhall.

Mr. R. W. Woolcombe then brought forward a paper "On Oblate Projectiles with Cycloidal Rotation contrasted with Cylindro-ogival Projectiles having Helical or Rifle Rotation."—The object of this paper was further to discuss the views of the author given in a paper read before the Royal Society in March last, entitled "An Account of some Experiments with Eccentric Oblate Bodies and Discs as Projectiles," and to show the result of further experiments. Rifled cannon, it appears, cannot project heavy elongated shot with high initial velocity; and, except with the Whitworth flat-headed shot, the penetration of iron plates can only be effected by means of a high velocity. The author considers that, however well the helical or rifle method with cylindrical elongated shot may answer for small arms, yet that, when we wish to project great weights with great and sustained velocities, we shall succeed better if our mechanical arrangements were less antagonistic than the rifle principle to the great laws of Nature, as exhibited in the form, method of rotation and translation of the great natural projectiles, the planets. None of these are prolate bodies projected with helical rotation about their longest diameters and in the direction of their axes. The author states that he has found it practicable to project a body that, instead of being prolate, is more or less oblate; that, instead of having helical rotation at the *expense* of translation, has cylindrical rotation in *aid* of translation. A projectile having a circular periphery in the line of motion in the gun, leaves the bore as a common round shot, and has the additional security for high initial velocity of windage less than for round shot of similar weight. The terminal velocity is also provided for by the oblateness, and by the axis of rotation being always transverse to and not in the plane of the trajectory. The gun has a similar transverse section to that of the projectile, the bore being straight and smooth. The projectile is a disc, and it should be *slightly* eccentric to make it rotate—so slight as to be little more than the inevitable excentricity of every spherical projectile. The author then gave the results of some actual experiments with a gun and projectiles made on this principle. The gun was 20¼ inches long; the calibre, long diameter 1⅝ inch, and short diameter ¾ inch. The shot weighed nearly 8 ounces, with a charge of 2¼ ounces, or ⅜ the weight of the shot; the penetration at 25 yards from an oak target was a mean of 11 inches, reckoning to the near side of the disc, and to the far side nearly 18 inches. The initial velocity, measured by Haver's Electro-ballistic Apparatus, was 1487 feet per second. A comparison was made with a small brass gun, length of bore 34·625 inches, or nearly double the length of the author's gun in calibres. The mean calibre of the brass gun was 1·6 inch, the mean diameter of the round shot was 1·43 inch; and this gun, fired with a proportionate charge of powder, showed that the disc gun gave more than double the penetration of the brass gun, and an initial velocity of 1487 to 1091 of the latter. He thought that these remarkable experiments showed that the subject was worthy of further consideration.

Mr. Le Neve Foster read a paper, communicated by Mr. C. Hart, "On Type Composing and Distributing Machines," in which the author described and pointed out the advantages of Mitchel's machine, shown in the western annexe of the International Exhibition, and which was stated to be in successful operation in several printing establishments in this country, and in the United States of America.

Monday, October 13th.

The President stated that, on Saturday, the Section had a very agreeable excursion to see the dam and syphons on the Middle Level near Lynn; and it gave him great pleasure to state that their friend Mr. Appold, a Member of the Section, had generously entertained the gentlemen, about 100 in number, who formed the excursion. He might add, as he very much regretted to do, that on Saturday evening another rupture took place in the Marshland sluice, similar to that which occurred on the Middle Level. He did not know the extent of the disaster that had occurred. He very much feared that the land in the neighbourhood would be inundated. He hoped that the means adopted for discharging the upper waters into the sea would be successful, and that the employment of syphons would prevent in future accidents of this kind. It was very important that investigation should be made into the causes which had been in operation to produce the destruction of these sluices; and he informed the Section that a Committee of the British Association had been appointed to investigate the tidal flow in the estuaries of the Nene and Ouse, having regard to the alterations which have of late years been made in these rivers, and their discharge into the sea.

The Secretary read a paper by Mr. C. Atherton, late engineer of the Royal Dockyard, Woolwich, "On Unsinkable Ships." The author pointed out the importance of having ships made of a material of less specific gravity than water; so that, whatever injury the ship may sustain so as to admit water, they would never sink, and thus both crew and ammunition or treasure might be saved. He considered such a build would be very valuable for small vessels, which could enter where the large armour-plated ships would be stopped. The idea, he thought, was worthy of consideration.

Dr. Fairbairn, the President of the Section, read a paper "On the results of some Experiments on the Mechanical Properties of Projectiles," He commenced by stating that, in the investigations which had taken place with regard to projectiles and armour-plated ships, one great difficulty that had arisen was to get good plates of sufficient thickness, and vessels of sufficient tonnage to carry those plates. It appeared that they were limited to plates of five inches in thickness; with plates heavier than that, a ship would not be what was technically called "lively." He had attended the experiments at Shoeburyness from the commencement, and they had reference to the force of impact. He would state the results of the more recent experiments, which had not yet been published. The first series of experiments had reference to the quality of the plates and the properties of the iron best calculated to resist impact. There were three qualities required: first, that the iron should not be crystalline; but secondly, that it should be of great tenacity and ductility; and thirdly, that it should be very fibrous. The mean statical resistance to crushing of the two flat-ended specimens of cast-iron is 55·32 tons per square inch. The mean resistance of the two round-ended specimens is 26·87 tons per square inch. The ratio of resistance, therefore, of short columns of cast-iron with two flat ends to that of columns with one flat and one round end is as 55·32 to 26·86, or as 2·05 to 1,—an extremely close confirmation of Professor Hodgkinson's law. Applying this same rule to the steel specimens, it would appear that the flat-ended shot should have sustained a pressure of 180 tons per square inch before fracture. In the experiment it actually sustained 120 tons per square inch without injury, excepting a small permanent set. In the experiments with cast-iron, the mean compression unit of length of the flat-ended specimens was ·0665, and of the round-ended ·1305. The ratio of the compression of the round-ended to the flat-ended shot was, therefore, as 1·96 : 1, or nearly in the inversed ratio of the statical crushing pressures. Applying this law to the case of the steel flat-ended specimen, it may be concluded that the compression before fracture would have been only ·058 per unit of length. The determination of the statical crushing pressure of the flat-ended steel shot as 180 tons per square inch and its compression as ·058 is important, on account of the extensive employment of shot of this material, size, and form in the experiments at Shoeburyness. In the case of the lead specimens the compression with equal weights was the same whether the specimen were at first round-ended or flat-ended. This is accounted for by the extreme ductility of the metal and the great amount of compression sustained. In regard to the wrought-iron specimens, it may be observed that no definite result is arrived at, except the enormous statical pressure they sustain, equivalent to 78 tons per square inch of sectional area, and the large permanent set they then exhibit:—

	Statical Resistance in Tons per Square Inch.	Dynamical Resistance in Foot lb. per Square Inch.
Cast-iron, flat-ended	55·32	776·8
Cast iron, round-ended	26·87	821·9
Steel, round-ended	90·46	2,515·0

In the experiments on the wrought-iron specimens, the flat-ended steel specimens, and the lead specimens, no definite termination was arrived at, the material being more or less compressed without any fracture ensuing. The mean resistance of the specimens of cast-iron is 800 foot lb. per square inch; that of the specimens of steel is 2515, or rather more than three times as much. The conditions which would appear to be desirable in projectiles, in order that the greatest amount of work may be expended on the armour-plate, are—1. Very high statical resistance to rupture by compression. In this respect, wrought-iron and steel are both superior to cast-iron; in fact, the statical resistance of steel is more than three times, and that of wrought-iron more than two and a half times, that of cast-iron. Lead is inferior to all the other materials experimented on. 2. Resistance to change of form under great pressures. In this respect hardened steel is superior to wrought-iron. Cast-iron is inferior to both. The shot which would effect the greatest damage to a plate would be one of adamant, incapable of change of form. Such a shot would yield up the whole of its *vis viva* to the plate struck; and, so far as experiment yet proves, those projectiles which approach nearest to this condition are the most effective. The President stated that steel shots might be made at a comparatively small cost. M. Bessemer had told him, that if he had a large order he could produce steel shots at a little more than the price of iron; but if the ingots as cast had to be rolled or hammered to give them fibre, they would cost near £30 a ton instead of £8 or £10 per ton.

Mr. J. Nasmyth inquired whether chilled cast-iron flat-headed shot had been tried? The process of chilling cast-iron was very simple and inexpensive. If chilled flat-ended cast-iron shot had not been tried, it was very desirable it should be.

Dr. Fairbairn said they had not been tried; but he believed that shot thus made being hardened to a certain depth, having its velocity the same, would in striking the object break as if it had not been hardened at all. However, he would have experiments made; and he hoped that before the next meeting of the Association the matter would be proved experimentally.

Mr. T. Aston read a paper "On Projectiles, with regard to their Power of Penetration." After alluding to the interest with which the contest between artillery and armour-plates has been watched by the country, he explained what was the actual condition of this important question so late as May last, by quoting statements which had been made in Parliament and elsewhere, that after all the vast expenditure upon our new artillery, the navy of England is compelled to arm herself with the old smooth bore, and that is the best gun the Navy actually possesses, though admitted to be so inefficient. Such being the state of the question a few months ago, Mr. Aston proceeded to consider, first, the reason why the artillery hitherto employed in the service (including rifled guns and smooth bores) has always failed to make any impression on the plated defences at ordinary fighting range; and, secondly, by what means artillery science has lately reconquered its lost ground. Three conditions were laid down as necessary to enable artillery to attack successfully armour-plate defences:—1st, the projectile must be of the proper form; 2nd, of the proper material; and 3rd, be propelled from a gun able to give it the necessary velocity. The artillery of the Ordnance Committee failed because they utterly neglected the first two conditions, and had recourse to the brute force of the smooth bore for the third. The expression accepted as representing the penetrating power of shot was "velocity squared multiplied by weight, but the form of the shot and the material were conditions altogether omitted from the expression; and the importance of the omission will be obvious at once if an analogous case—say a punching machine employed to perforate wrought iron plates—be taken. What would be the result if the punch, which is made of suitable shape and material, were removed, and a round-headed poker, of brittle cast iron or soft wrought iron, were substituted in its place? The great importance of velocity was conceded at once—it is a *sine quâ non* condition; but there has been great misconception in supposing that the old smooth bore gives a greater initial velocity than the rifled gun, as the results obtained would show. The average initial velocity of the 68-pounder is, in round numbers, 1600ft. per second, with a charge of powder one-third the weight of the shot, the length of the shot being, of course, one calibre. Sir W. Armstrong stated, that with a charge of powder one-quarter the weight of the shot, he obtained with his rifled gun an initial velocity of 1740ft. per second. He did not state the length of his projectile. Mr. Whitworth, with a projectile two calibres long, obtains an initial velocity of 1700ft. per second; and with a projectile one calibre long, like that of the smooth bore, an initial velocity of 2300ft. per second, being greater than that of the smooth bore in the proportion of 23 to 16. The following table shows the actual results obtained by various guns:—

Gun.	Range.	Projectile.	Powder Charge.	Penetration into Armour Plate.
			lb.	
Armstrong 110-pounder	200	110 lb. solid	14	$1\frac{1}{2}$ to 2 inches.
68-pounder smooth-bore	200	68 lb. solid	16	$2\frac{1}{4}$ to 3 inches.
Whitworth 70-pounder	200	70 lb. shot & shell	12	Through plate & backing.
Whitworth 120-pounder	600	130 lb. shell	25	Through plate & backing.

The first two results show that the Armstrong rifled gun is a worse compromise than the old gun it was intended to supersede. It is worthy of notice, that the velocity of the Whitworth heavy projectile, after traversing 600 yards (a good fighting range), was 1260 feet; being 50 feet greater than the initial velocity of the Armstrong projectile, which is 1210 feet at the muzzle of the gun. The total results in respect of penetration being so decidedly in favour of Whitworth, it follows that he has adopted the best compromise, by combining all three necessary conditions of proper form and material of projectile and sufficient velocity. That the velocity, though perhaps at the muzzle of the gun slightly below that of the smooth-bore, is sufficient when combined with proper form and material of projectile, is shown by the penetration result, which in the case of the Whitworth is through and through both armour-plate and backing; in the case of the smooth-bore is barely half-through the armour-plate; and in the Armstrong is not half-through. The form of projectiles, both shot and shell, employed by Mr. Whitworth for penetrating armour-plates, was then described. The material of which the projectile is composed is what is termed homogeneous iron—combining the toughness of copper with the hardness of steel. It undergoes a carefully regulated process of annealing. The same metal is used for the Whitworth field guns; and practical improvements now enable it to be worked in masses of any requisite size, whose quality may be henceforth depended upon with certainty. Mr. Whitworth is therefore now making his heavy ordnance with both interior tubes and outer hoops of homogeneous metal of the improved manufacture; so that the guns will be constructed of one uniform metal, without any welding at all. Experience justifies the expectation that they will be free from the objections which it is well known are inherent in all welded guns, and be fully able to resist the severe and searching strain that is sure sooner or later to disable a gun built up of forged coiled tubes, if it be called upon to do its full work by discharging heavy projectiles at efficient velocities.

Mr. Nasmyth said the steam-ram was an old subject with him. A plan was proposed by him to the Admiralty so long ago as 1845. He thought the more destructive you can make the attack on your adversary the better. It was not right to be torturing your enemy by drilling numerous small holes in him; it was like taking a whole day to draw a tooth. His idea was to make one large hole and sink the ship at once with the enemy. It was a question of momentum. The first practical ram was the *Merrimac*; but the Southerners made a mistake in giving her a sharp end; it should be blunt; and such was the original plan of the author, nor had he seen any reason to alter his views. The vessel must present as low an an angle as possible to turn shot; but she must also have strength in the direction of her length, and use the utmost possible amount of steam to get velocity; and, to meet the objection that the impact might destroy the engines, which he did not anticipate, he would place the engines on a slide, with buffer arrangements. With such a vessel he would dash into the *Warrior* as into a bandbox. The plates would be crushed at once. He hoped the Admiralty would devote a thousand pounds or two to try the effect of a ram against some old hulk, then the *Trusty* with armour-plates, and afterwards against the *Warrior* herself; and he thought it would be best to knock a hole in her ourselves, in preference to having it done by an enemy.

Mr. Webster hoped that in the discussion they would not omit the question, brought before the Section by Mr. Atherton, of unsinkable ships. It was quite clear from the late experiments that ships could not withstand the attacks of guns, and there was a reason why we should give some attention to other matters of ship architecture than the mere attempting to defend them by armour-plates against shot.

Admiral Sir E. Belcher observed that he had urged a plan of unsinkable ships to Sir Robert Seppings by shutting down the hatches and using the pumps to pump in air; but this was objected to, on the ground that it was necessary to have an opening to keep the timbers sound. He advised water-tanks as a backing to the sides of ships, believing that such an arrangement would withstand even Mr. Nasmyth's ram.

Mr. R. W. Woollcombe explained the nature of his projectile, by means of which he got rid of the friction caused by rifling, with no more windage, the projectile being a disc travelling in a direction perpendicular to its axis of rotation.

Mr. G. P. Bidder, jun., observed, that with a smooth-bore the balls go accurately for a short distance, but afterwards they diverge in uncertain directions; and this he showed must be the case as well with Mr. Woollcombe's shot as with an ordinary smooth-bore shot.

Captain Blakeley said that Mr. Aston had told them that Mr. Whitworth was beginning to use homogeneous metal for the inside and the outside of his guns; and he (Captain Blakeley) would encourage him to use this, as he had for several years past used it with great advantage. He had made guns, in use abroad, of large size, which would throw rifle 600lb. shot with 80lb. of powder. The Spaniards had such guns; and he thought the English Government ought to give some encouragement for trials of every kind of gun as well as rams.

Mr. J. Scott Russell said at the last meeting it was ascertained that $4\frac{1}{2}$in. plates and 18in. of wood would beat the gun; but the late experiments had shown that we have no navy if you keep wooden ships with iron plates. Sir W. Armstrong fired our wooden ships, and Mr. Whitworth had proved that he can do the same if the ship be plated. No ship of ordinary size was big enough to carry indestructible plates. Why could not a good fighting ship be made which should keep out a shell? He believed that Whitworth's shell would be stopped by double armour plates, one in front and the other behind it; but a larger one, it was said, would be made which would destroy any thickness of double plates; and he believed it would be done. There was one way of carrying increased thickness—namely, by the increased size of vessel. There was, however, another way without increasing the size—to build the ship up but little beyond the water's edge; cover her below the water line as far as was necessary to prevent penetration; then diminish the battery on the deck, and then they would have a vessel somewhat like the *Monitor*, absolutely shot-proof. Captain Coles's ship was, he believed, on that principle.

Dr. Robinson had lived long enough to learn that such prefixes as "im" and "un" were very unsafe syllables to deal with, whether as applied to unsinkable ships or the impossibility of making shot-proof ships. He thought, however, that the materials for unsinkable ships would have no power of resistance. He wished to know as to the price of a gun of the homogeneous metal as compared with one on the Armstrong principle.

Mr. Aston said that the price of homogeneous metal was gradually being lowered, and that the Whitworth gun could be produced at a lower price than the Armstrong.

Dr. Robinson, in continuation, observed that such was the arrangement of the Whitworth gun, that the friction in the barrel was reduced to a minimum. The shot would fall from the barrel with a very small inclination. He thought that Mr. Woollcombe's shot promised advantages in some respects, but he pointed out great disadvantages.

Mr. Aston asked what would be the condition of Mr. Scott Russell's ship with shells which would penetrate 30ft. below the water-line? and this, Dr. Robinson had told them, was possible. As to the partially-defended ship, would any captain ask his men, some to stay in the undefended part, while others were comfortably ensconced behind 8 inches of armour-plate? He (Mr. Aston) considered that guns built of rings could never stand.

The President said the great difficulty about homogeneous iron was its liability to be of unequal quality. Mr. Whitworth took very great pains in the manufacture, and the great danger in the case of the coils is that they are apt to elongate.

A short discussion then took place on Mr. Thorold's paper "On the Failure of the Sluice in the Fens, and the Means of securing such Sluices against a similar Contingency."

ON THE IMPORTANCE OF ECONOMISING FUEL IN IRON-PLATED SHIPS OF WAR.

By Edward Ellis Allen, A.I.C.E., M.I.M.E.

The object of this paper is to point out the very great importance of economising the consumption of fuel in iron-plated ships of war, and to show how this may best be done. It is a subject which has been sadly neglected, notwithstanding these vessels have been constructed to carry several hundred tons additional weight, even when only partially protected.

This increase of weight has been met to some extent by reducing the number of days' fuel carried; so that instead of these vessels coaling for fourteen days, which, in the opinion of most persons, is the least they should do, the quantity has been reduced to considerably less than one-half. With bad or indifferent coal this time would be reduced to perhaps four days' consumption when full steaming, *i.e*, when the engines are working up to say four times their nominal power. Moreover the high rate of speed considered desirable for these vessels necessitates a corresponding increase in the power of the machinery, which of course, under any circumstances involves an increase in the fuel consumed, or, in other words, reduces the time during which a given quantity of fuel lasts.

Further, it is highly probable that in future wars great despatch will be necessary in moving vessels from one station to another, not only from the fact that for many years to come there will be comparatively few iron-cased vessels in the navy, but also from the increased rapidity with which warlike preparations must be made. This also will tend to increase the quantity of fuel consumed.

Even in time of peace it will be difficult to reconcile ourselves to war steamers going far under sail alone; and when the whole of the working expenses of a large ship of war are taken into account, it may be the more economical course to put her in commission so many weeks later, and then let her steam to her destination. Indeed it cannot be doubted that the same causes which have operated in supplanting sailing vessels by steamer, will also induce the use of the steam power more and more as time advances.

There are thus several important reasons why every effort should be made to economise the consumption of fuel in the ships of our new iron-plated fleet, viz.:—Additional weights, increase of speed and distance to be steamed, increased despatch in moving from station to station, and of time during which steam power will probably be used even under ordinary circumstances, and increase in the cost of coals, owing to the continually increasing size, power, and number of steam ships in the Royal Navy.

To these reasons for economising fuel we may add:—The universal deficiency of boiler power in ships of the Royal Navy, necessitating a relative increase of space being allowed for this portion of the machinery; as also the fact now generally admitted that much smaller vessels than those first constructed will be necessary in order to constitute an efficient fleet; these small vessels being of course as thickly plated as the very largest, if not more so, on account of their speed being considerably less.

Table of all Iron-Cased Ships and Floating Batteries building or afloat, with assumed weights of their armour plating, and quantity of Coals carried, the latter deduced from difference of draught with and without Coals.

Name of Vessel.	Afloat or building, &c.	Iron or Wood.	Wholly or partially cased.	Length.	Beam.	Mean Draught ready for service.	Difference without coals.	Tonnage.	Nominal H.P.	Assum'd weight of coals carried.	Assum'd weight of armour plates
				feet in.	feet in.						
Agincourt	Building	Iron	Partially	400 0	59 3½	25 8	1 7	6221	1,350	1,000	850
Minotaur	„	„	„	400 0	59 3½	25 8	1 7	6621	1,350	1,000	850
Northumberland	„	„	„	400 0	59 3½	25 8	1 7	6621	1,350	1,000	850
Achilles	„	„	„	380 0	58 3½	26 3½	1 10½	6079	1,250	1,000	800
Black Prince	Afloat	„	„	230 2	58 4	25 11	1 8	6109	1,250	950	800
Warrior	„	„	„	230 2	58 4	25 11	1 8	6109	1,250	950	800
Hector	Building	„	„	280 0	56 3	24 8	1 0½	4063	800	450	450
Valiant	„	„	„	280 0	56 3	24 8	1 0½	4063	800	450	450
Defence	Afloat	„	„	280 0	54 2	24 11	1 4	3720	600	550	450
Resistance	„	„	„	280 0	54 1	24 11	1 4	3710	600	550	450
Caledonia	Building	Wood	Wholly	273 0	58 5	25 10½	1 6½	4045	1,000	650	950
Ocean	„	„	„	273 0	58 5	25 10½	1 6½	4045	1,000	650	950
Prince Consort	Afloat	„	„	273 0	58 5	25 11½	1 7½	4045	1,000	650	950
Royal Alfred	Building	„	„	273 0	58 5	25 10½	1 6½	4045	800	650	950
Royal Oak	„	„	„	273 0	58 5	25 10½	1 6½	4045	800	650	950
Royal Sovereign	Converting	„	„	240 7	62 0½	22 11	1 5	3963	800	550	750
Prince Albert	Building	Iron	„	240 0	48 0	20 0	1 9	2529	500	230	750
Favourite	„	Wood	„	225 0	46 9	20 5	1 4½	2186	400	400	—
Enterprise	„	„	Partially	180 0	36 0	14 7½	1 7½	990	160	100	—
Erebus	Afloat	Iron	Wholly	186 8½	48 8	8 9	1 3¼	1954	200	80	—
Terror	Floating batteries	„	„	186 3	48 8	8 9	1 3¼	1971	200	80	—
Thunderbolt	Floating batteries	„	„	186 11	48 5¾	8 9	1 3¼	1973	200	80	—
Ætna	Floating batteries	Wood	„	186 0	43 11	8 2	1 3	1588	200	300	—
Glatton	Floating batteries	„	„	172 8	45 2½	8 9	1 3	1535	150	60	—
Thunder	Floating batteries	„	„	172 6	43 11	8 11	1 4	1469	150	80	—
Trusty	Floating batteries	„	„	173 6¼	45 2¾	8 8	1 3	1539	150	60	—

From the particulars in the accompanying table it may be stated with sufficient accuracy that in most of our iron plated ships the weights of the three items, viz., the armour plating, the machinery, and the fuel, are very nearly equal, and that together they constitute about one-third of the total displacement, *i.e.*, in vessels plated amidships only. Marine engines of good construction, when working full power, exert a force, when measured by indicator, considerably above their nominal power; and it is a rule with the Admiralty that all engines supplied to them shall work up to at least four times this nominal power. Now the average consumption of fuel in marine engines of the ordinary but best construction being about 4½lb. per indicated horse-power per hour, it follows that a nominal horse-power requires about 4 cwt. of best coals in the day of twenty-four hours, so that a 1000-horse-power engine would consume something like 200 tons of coal per day when working full power. Comparing this quantity with

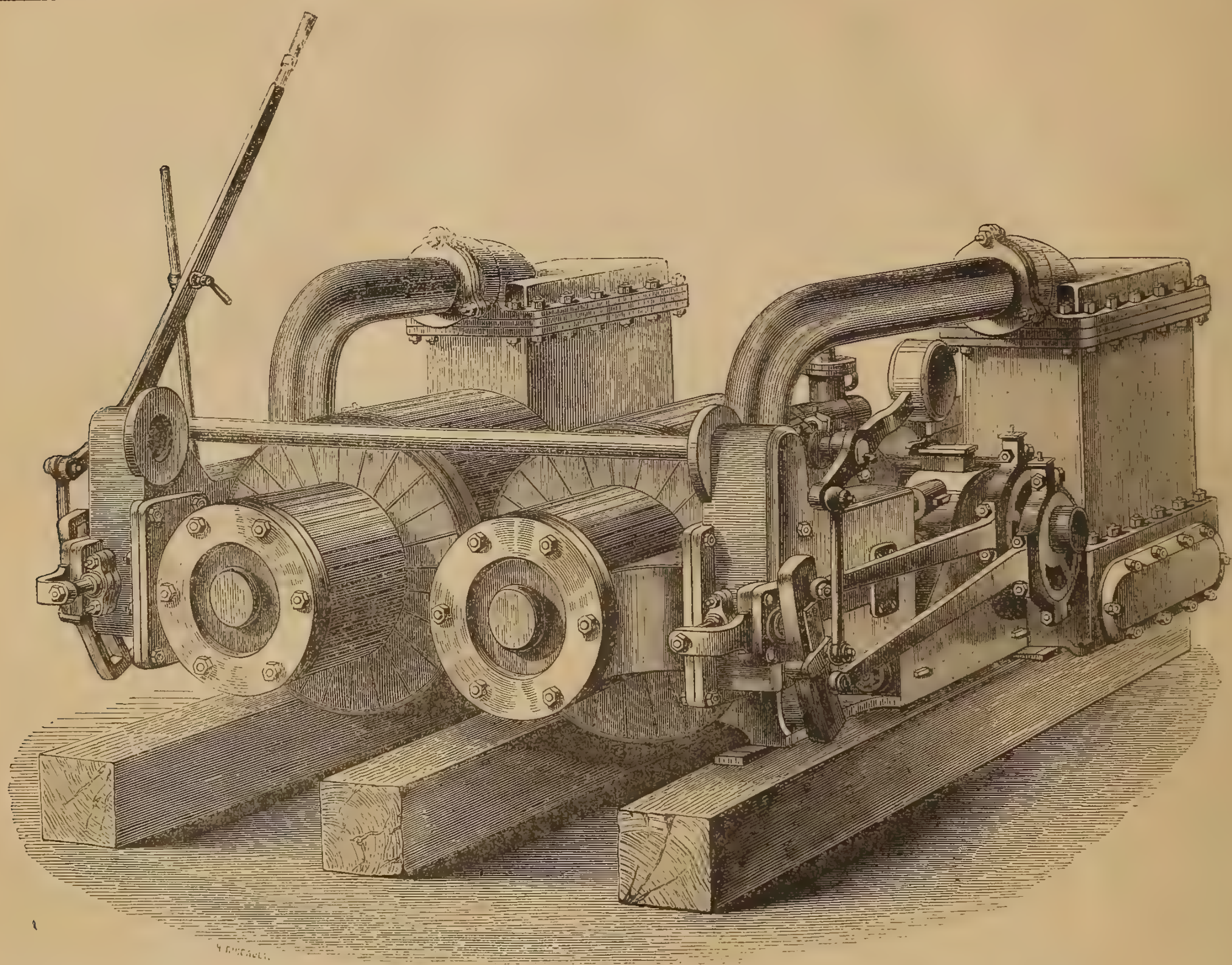


FIG. 1.

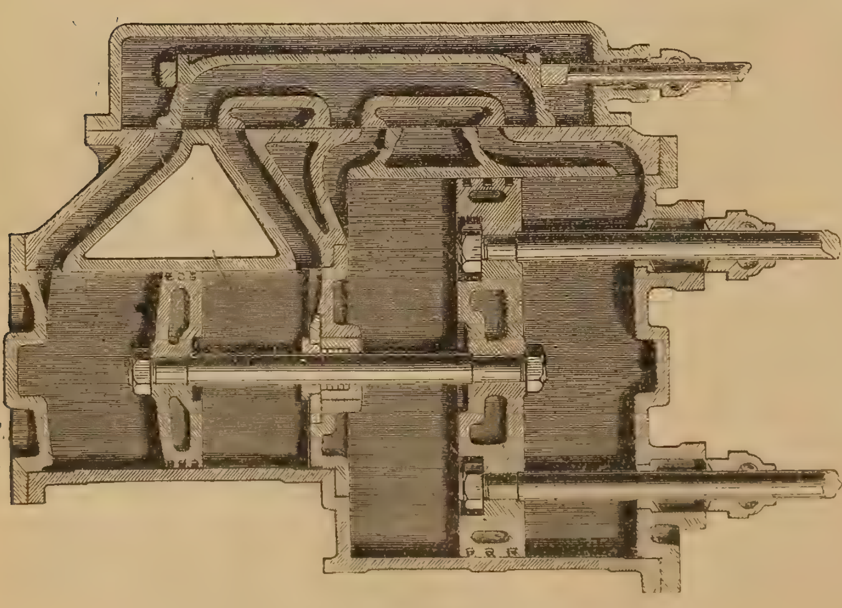


FIG. 3.

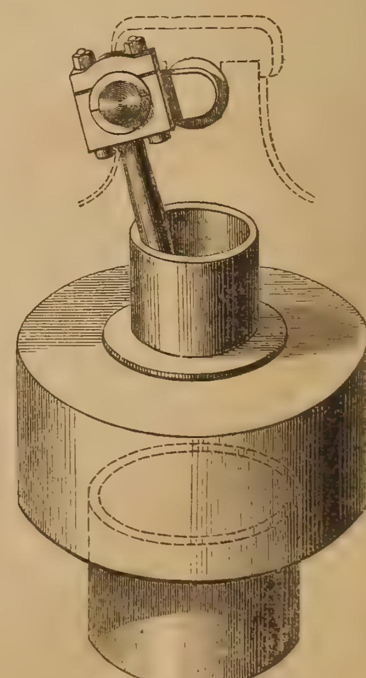


FIG. 4.

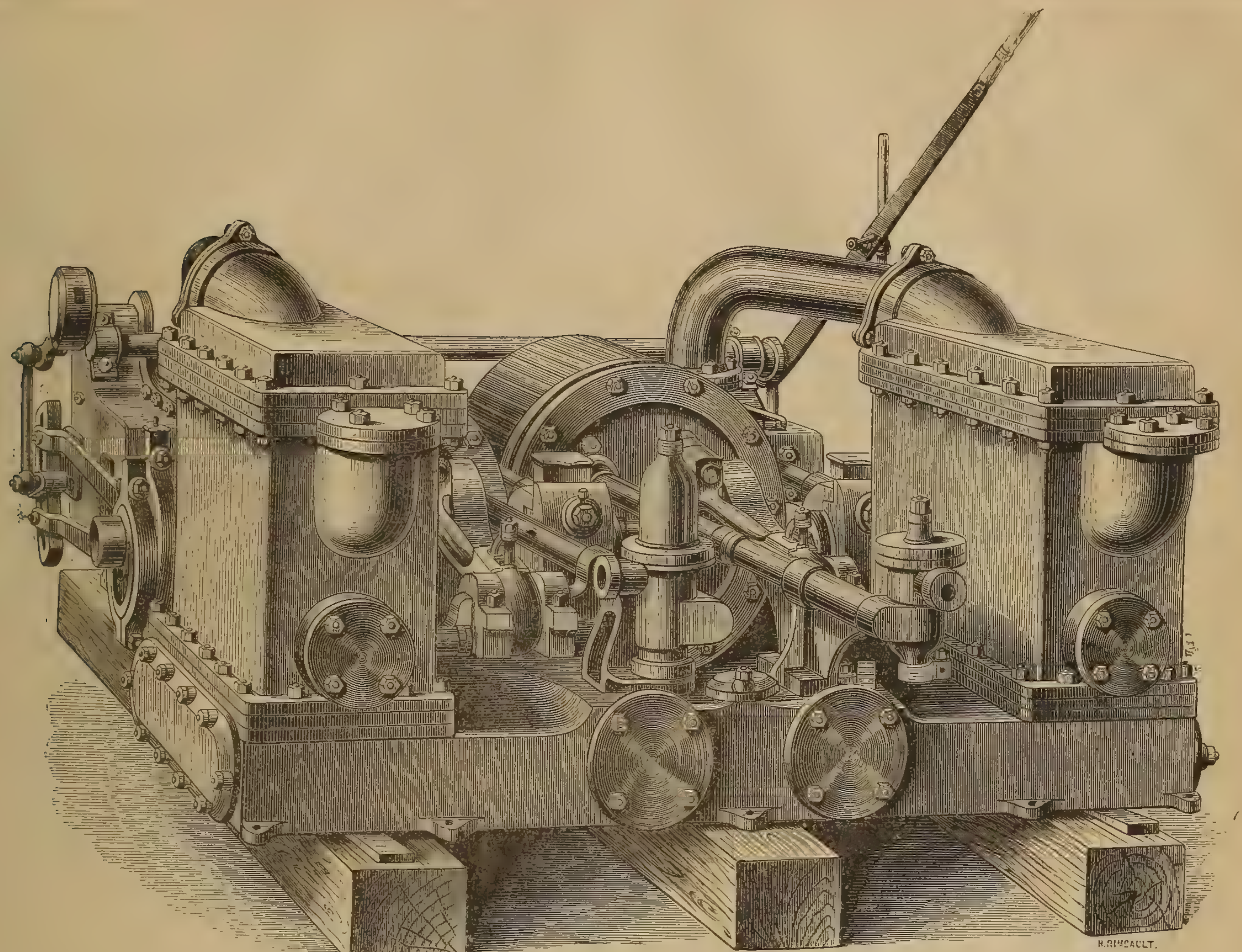


FIG. 2.

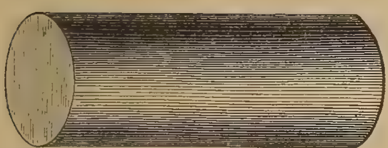


FIG. 5

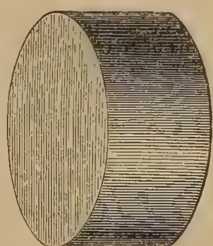


FIG. 6.

that for which stowage is given in the iron-plated ships of the Royal Navy it will be seen that the best of them carry no more coal than would serve them for about four days' full steaming.

We are, nevertheless, told that in all or nearly all cases, seven days' supply is provided, but this can only be on the supposition that the engines are not intended to work full power the whole of the time; indeed, with the ordinary boilers used on board war steamers, this is not possible, for it is well known that full steam cannot be kept for more than twenty-four hours together.

The very great increase of power necessary to propel any given vessel at an increased speed renders it a matter of some difficulty to obtain a rate of speed in the iron-cased ships such as that believed to be desirable, or rather necessary, by those competent to judge. If a certain power be necessary to drive any given vessel of good form at ten knots per hour, then to increase the speed of the same vessel to twelve knots, will require nearly double that power; to increase it to fourteen knots the power must be nearly three times as great, and to increase it to sixteen knots the power will require to be more than quadrupled. The estimated speeds of our new ships of war, even in smooth water, are considerably less than those thought necessary *at sea* by naval men and many others, and the difference is as much as one and a half to two knots per hour.

Six of the largest vessels are estimated to attain about fourteen knots per hour; five of them about twelve knots; two of them about eleven and three-quarter knots per hour; four of them about eleven knots; one about ten and three-quarter knots, and one only nine and a half knots; and in the vessels tried, even these speeds have not been attained; whereas fifteen knots per hour has been very generally assigned as the speed below which our new iron-plated ships of war should not be propelled when at sea.

In favour of such a speed we have the opinions of Mr. Scott Russell, Mr. Samuda, Captain Halsted, Commander Oldmixon, Admiral Moorsom, and many others.

With regard to the distance which such vessels should be able to go without re-coaling we have the most distinctly expressed opinion of Mr. Scott Russell and Captain Halsted, as well as those who have commented upon their views, that 5000 miles should be the mimimum, wherease none of our ships could, with their ordinary supply of coal, go one-third of that distance.

With respect to the increased cost of coaling the ships of the Royal Navy, it will be found that the charge on this head is now over £300,000 per annum, and in war time more than double the ordinary amount is expended. What shall it be, even in times of peace, when a fleet of iron-cased ships of the *Warrior* class shall have been formed? We may indeed view with some alarm the amount of this item in the naval estimates of future years, unless something be done to diminish the consumption of fuel in marine engines.

Regarding the necessity of economising fuel in ships of war, on account of the insufficiency of boiler power at present allowed, it will be only necessary to quote the opinion of the present Surveyor of the Navy, expressed by him when in charge of the steam reserve at Portsmouth, in 1858. He says:—"As far as my experience goes, no ship of any class or with any makers' engines has sufficient boiler space; there is not one of the multitudes I have tried that has steam enough to keep the throttle valve open for two hours. The steam drops directly the vessel goes over nine knots, and this not in one or two, but in all without exception. . . Nothing is so wasteful of fuel as too small a boiler: intense firing and incomplete combustion of the fuel is the inevitable result of trying to keep up steam in such a case. . . . Not a step is made in the right direction of obtaining speed and economy until more attention is paid to the proper proportion between the quantity of steam used in the cylinders at each stroke, and the quantity remaining in the boiler."

He says that 600-horse power boilers should be used where 450-horse power boilers are now employed, and the ships would go faster, not perhaps rush past the measured mile quicker, but in a chase of four or five hours.

The Committee on Marine Engines, reporting upon this and other evidence, observe:—"From the evidence taken by the Committee it appears that in general the boilers supplied to our men of war are deficient in generating steam, and that full speed in consequence can only be maintained for a short time. Now the remedy of that defect must necessarily involve the whole question of the amount of space that can be allotted to the boilers; the Committee, therefore, consider that they need not enter into further details, and that they do their duty by simply, and without comment, bringing the question before their lordships."

Of the last reason named for encouraging economy of fuel, no better illustration can be given than that of the *Enterprise*, the first small ship in course of construction by the Admirality, plated with armour. In this case the employment of ordinary machinery (excepting having surface condensers), not only necessitates the quantity of fuel taken being reduced to a very few days' steaming, but the speed with which we are to be satisfied is an "estimated" one of nine and a half knots only. What will this be as an average at sea? Possibly not over eight knots.

Enough has now been said to show that economising the consumption of fuel in iron-plated ships of war is a subject of the very gravest importance: and although this will be admitted generally, and, perhaps, by none more readily than the authorities of the Admiralty, it appears practically to have received far less attention than it deserves. It is hardly saying too much when we state that coal is the only item in which weight can be saved.

It has been long known that many vessels in the merchant service have been working now for some years upon just one-half of the fuel consumed in ships of the Royal Navy. In proof of this, although evidence is abundant, I shall give simply the opinion of Mr. Charles Atherton, late Chief Engineer of Woolwich Dockyard, and that of Mr. Andrew Murray, Surveyor to the Board of Trade. Mr. Atherton, in a paper read at the British Association, three years ago, says, "I believe the ordinary consumption of fuel in steam ships of the Royal Navy is fully 50 per cent. in excess of the amount of 2½ lb. which has been practically realised on continuous sea service."

Mr. Murray, in his paper on "Means and Appliances for Economising Fuel in Steam Ships" (read in March, 1860), says:—"It is hoped and believed that the day is not far distant when the average consumption will be reduced to nearly one-half of what it now is. In Cornwall, ninety millions of pounds raised one foot high in an hour by a bushel (or 94 lb.) of coal is considered fair work for a good steam engine, which corresponds to nearly 2¼ lb. of coal burnt per indicated horse power per hour. It is not likely that this degree of economy can ever be permanently maintained *at sea*; but if our marine engines can be induced to content themselves with 3lb. or even 3½ lb., this will still be a vast improvement on the present average consumption." What this is he states in his work on "Steam Ships" in these words:—The more usual consumption of modern marine engines varies from 4 lb to 5 lb. per indicated horse power per hour, and the average consumption of all classes cannot be less than 6 lb.

It may be here observed that the Admiralty returns contain no statement of the consumption of fuel of ships of the Royal Navy; but this omission having been compiained of for many years past, the Committee on Marine Engines recommend that the consumption of coal per indicated horse power, as well as the quality of coal and evaporation of water, should be given in future.

The fact of vessels running continuously on half the fuel consumed in Government vessels is now well known, as are also the principles of construction on which this important saving is made. They may shortly be stated as follows:—

1st. Proportionate increase of boiler power.
2nd. Expansion of the steam to say 5lb. pressure.
3rd. Jacketing cylinders.
4th. Superheating the steam.
5th. Condensing by surface instead of by jet; and
6th. Heating the feed water.

And all this may be done without increasing the pressure of steam above 20lbs. or 25lbs., although the higher the pressure of steam, the greater the economy of fuel.

It is difficult to assign the exact proportionate value of each of these six modes of economising fuel, as they have seldom, if ever, been so far separated as to admit of correct deductions; but, taken altogether, there is now no doubt that *fifty per cent.* may be saved in the ordinary consumption of fuel. This saving has been practically effected in several vessels where the principles above stated have been carried out.

In the early part of 1855 the author read two papers at Birmingham on "The Commercial Economy of Expanding Steam in Marine Engines," and described several new forms of engines suited to this purpose, and ever since that time, has endeavoured to direct the attention of steam-ship companies and owners, as well as that of the Admiralty, to the subject.

In 1858 the author sent detailed drawings of engines to the Admiralty, the designs being made with a view to effect a very large saving in fuel. One of these was that of concentric cylinders, with three piston rods and cross head, the two outer rods being carried to a guide block, from which the connecting rod was returned to the crank; this arrangement being precisely that adopted in the Swedish gunboats, and for which a medal has been awarded to the maker in the Exhibition.

In the early part of the present year the author again addressed the Admiralty, calling their attention to this subject, and requesting the favour of an examination of the engines constructed on his patent of 1855, by Messrs. J. and G. Rennie, and which may be described as double expansive end-to-end cylinders, the small cylinders being placed at the back of the large one, motion being communicated to the crank by means of double piston rods. (Figs. 1, 2, and 3.) This arrangement has, it appears, been recently tried on one of the Swedish vessels of war, the results of working being, it is said, very satisfactory. If, therefore, the Swedish engineers have not the faculty for designing economical marine engines they may, at least, take credit for duly appreciating what others do, and in this respect are considerably in advance of some of the engineers of our own country.

In these several applications to the Government, the author's object was to show how the expansive principle could, in his opinion, be best carried out in ships of war, fulfiling the necessary conditions of such vessels, *i.e.*, of keeping the weights down as much as possible and the machinery below the water level.

He showed, in his papers, that the suggested alterations in marine engines could be made without either adding to the gross weights carried or to the space occupied in the ships, and that a very considerable saving of coal would be the result; increased capacity of cylinder to allow of full expansion of the steam being, of course, under every possible arrangement absolutely necessary.

One of the forms of marine engines suggested by the author in 1855 has lately been adopted in the case of the Poonah's engines, (Fig. 4), now building by Messrs. Humphreys and Tennant, the small and large cylinders being placed end to end, as first described, with reference to the engines made by Messrs. Rennie, but motion being given to the crank shaft by means of a trunk working in the large cylinder.

For these several forms of double expansive engines may be claimed many advantages, which are shortly these:—

1. Capability of fully expanding the steam without the use of expansion gear.

2. Great uniformity of motion by reason of the steam from the boiler acting upon a comparatively small area, and pressing upon the large pistons until partially expanded.

3. Saving of considerable weight on account of the strength of the connecting rods, piston rods, &c., being only necessarily proportioned to the pressure of the initial steam on the small piston and the expanded steam on the large area, instead of the initial steam on the latter; or, rather, upon a considerable extension of it, as in the case of a single acting cylinder designed for great expansion, its area must be greatly increased, the stroke not being capable of being lengthened.

4. Considerable saving of steam owing to the loss in the clearances in the small cylinder being made less than that in a very large cylinder, the loss in the latter case absorbing a large percentage of the steam.

5. The cylinders being in line with each other, no increase in the number of piston rods, connecting rods, or guides is necessary.

6. That, practically, all the advantages of a long-stroked engine are obtained without increasing the stroke, and which cannot be done owing to the speed of revolution of direct acting screw engines being necessarily high.

7. That by fully expanding the steam, a far less quantity suffices for the production of a given power, this allowing of the boilers being reduced a third or a fourth, still leaving a large proportionate increase in boiler power compared with the steam required.

It will be readily admitted on all hands that very considerable difficulties would be found in making ordinary marine engines fully expand their steam, an increase in the capacity of the cylinder of from two to three times being essential.

At present the shape of the cylinders of marine engines approaches to that of those of rivetting machines, their diameter being frequently $2\frac{1}{2}$ times the stroke; whereas in pumping engines, in which economy is studied, the cylinders assume an entirely different form, their lengths being three times their diameter, as shown in Figs. 5 and 6, which represents cylinders of the same capacity, the former similar in shape to those of the 1350 horse-power engines constructing for the largest iron-plated ships, and the latter the cylinder of an ordinary pumping engine. Indeed, all engineers admit that, in very short cylinders, *i.e.*, single-acting ones, economy is out of the question. It is greatly to be regretted that in our iron-plated ships, even in those of the largest class, the same form of engines has been adopted as was employed fourteen years ago, notwithstanding Mr. Atherton, the late engineer at Woolwich Dockyard, recommended some years ago that "double expansive engines ought to be tried," especially as super-heating of the steam had been carried out.

Mr. Murray has rather severely remarked upon "the plan adopted by the Government of contracting for their steam machinery with only a few favoured and old established houses," and states that this, "though perhaps justifiable in other respects, has undoubtedly tended to promote conservatism in marine engines, and to repress innovations and improvements, . . . competition being scarcely roused into action. . . . In the case of those manufacturers, . . . however, who are dependent upon the custom of the great steam shipping companies, and other private owners of steam vessels, who have a strong interest in this question, there exists an active competition, and, consequently, a powerful inducement to improve upon the economical performance of their machinery. We find, accordingly, that it is this class who have taken the lead in the steam reformation which has recently set in."

The practibility of saving so great a per centage of fuel being now so well known, how is it that the whole of our iron-cased fleet at present in existence or ordered, are doomed to consume double the amount of fuel which is necessary?

In the twenty-six iron-cased ships constructed and constructing, a force of no less than 18,310 nominal horses power is to be employed; and when working full power power, every day will witness an unncessary consumption of upwards of 1700 tons of coal, which, on foreign stations, would certainly amount to more than £5000 sterling.

This loss is, however, not what is to be most regretted; but rather the fact that our iron-cased fleet, the largest vessels of which are to cost upwards of £350,000 each, and are provisioned for four months, should only carry coals enough for from four to five days' steaming. It is surely a sad pity that these vessels should have to creep into port every time after steaming, say 2000 miles, or else waste days, and perhaps weeks, of valuable time on full commission pay, in attempting to reach their destination by the use of sails?

If it be maintained that the quantity of coals carried is sufficient—which, probably, the Admiralty authorities would hardly acknowledge—even then is it not better to increase the armour plating, or the speed of the vessels, by reducing their draught or increasing the power of the engines rather than carry an unnecessary quantity of expensive fuel?

It is now certain that the speed of the *Warrior* and *Black Prince* is much below what was anticipated. And even if a speed of fourteen knots were obtained, under the most favourable circumstances of clean bottom, clean tubes, and fair weather, this would be reduced to about twelve knots at sea, running days together; and this is no less than three knots below the speed that has been considered necessary.

Again, if the present quantity of fuel carried be enough, the engine power could be increased some 40 per cent. without increasing the draught of water, and still allow of the same number of days' fuel. This increase of power would increase the speed about one knot and a half per hour, which cannot be regarded as a matter of slight importance.

With these facts before us, the question arises, are we justified in continuing to employ engines of the ordinary kind in our iron-plated ships of war? In considering this matter we must be careful not to confound the excellency of workmanship of Government engines, which is all that can be desired, with correctness in the principles upon which such machinery is made and worked.

The wasteful expenditure of fuel in all vessels having ordinary but first-class machinery, arises of course from the principles upon which it is made and worked being faulty; such as filling the cylinders three parts or seven-eigths full of steam, and only expanding in the remaining space; condensing by jet; not superheating the steam or heating the feed-water; confining the boiler space in proportion to the steam used (although this space in proportion is much greater than required under improved conditions); not jacketting the cylinders; and, finally, using short-stroked single expansive engines.

No amount of excellence in workmanship can ever make up for this total disregard of every principle which experience has shown to be necessary to economical working.

Our present navy consists of vessels in which there is a nominal power of upwards of 142,000-horses, distributed in about the following proportions:—

	Horse-power.
Ships in commission	60,000
Do. in ordinary	51,000
Do. used as transports, &c.	13,000
Do. (new iron-plated) and batteries	18,000
Total	142,000

The ultimate extent of our iron-cased fleet, of course, is not as yet known, but taking the very moderate estimate made by Mr. Scott Russell, we have yet engines to provide to the extent of, at least, 60,000-horse power, making a gross power of 200,000-horses.

Assuming that one-half of these vessels are in commission in time of peace, the *daily* consumption of coal when working full steam would be over 15,000 tons at the present rate per indicated horse power.

Now, ships in commission may be fairly assumed to be one-third of their time under steam, say two days per week, or 100 days in the year. They will probably be half this time under easy steaming, and the remainder three-quarters and full steaming, and will consume from $2\frac{1}{2}$ to 3 cwt. of coal per day, or 14 tons per annum per nominal horse-power, or for the whole of the ships in commission about 1,400,000 tons per annum.

This is, then, what we may look forward to in the navy returns in future years of peace, *i.e.*, if the present consumption of fuel be maintained. It is just half this quantity which experience has now fully proved may be saved by a modification in the mode of constructing and working marine engines, and it is to the cost of this quantity, which could be saved, and the advantages arising from its absence in the vessels, that attention is now invited.

Applying the same calculations to the engines of the twenty-six iron-cased vessels made or ordered, or omitting the floating batteries and some of the vessels in ordinary, it appears more than probable that had these vessels been fitted with improved machinery, a *money* yearly saving would have been made sufficient to purchase at least one iron-cased vessel annually from saving in the consumption of coal. This gain, it must be remembered, is quite distinct from the other numerous advantages which have been referred to, and of which no estimate can be made; the very existence of the ships being, perhaps, jeopardised by either want of coal or want of speed.

This saving of fuel whenever brought about will, without question, give us one or other of the following advantages, in addition to the money saving, viz.:—

Increase of armour plating 50 per cent.; or,
Increase of speed to the extent of one knot and a half; or,
Increase of number of days' fuel to double what it now is; or,
Diminished draught to the extent of 8in. to 12in., according to the vessel.

Thus enabling us to have armour-plated vessels of comparatively very small tonnage.

To all this we must not forget to add the loss of time, expense, and inconvenience, of frequent coaling when only five to six days' supply are carried; and, again, the cost and labour of trimming the coals and feeding the furnaces with double the quantity which would be needed with good double expansive engines.

It is hoped that these considerations will induce the Lords of the Admiralty to turn their attention to the advantages of working steam expansively in the vessels of the Royal Navy, not simply has it has hitherto been done, and when the power is proportionately diminished and no saving effected, owing to the machinery not being adapted for expansive working, but constantly and regularly in ordinary working and under proper conditions, when its advantages would be at once experienced.

In conclusion, it is only fair to mention that soon after the appearance of the report of the Committee on Marine Engines, recommending that the number of contractors for Government engines should be increased, and that the best engines should be adopted in ships of the Royal Navy, by whomsoever proposed to be supplied, orders were issued for three pairs of engines, designed to work with less fuel than usual. Messrs. John Penn and Son supplied a pair of large trunk engines, with surface condensers; Messrs. Maudslay a three cylindered arrangement, also with surface condensers, designed by Mr. Sells; and Messrs. Randolph and Elder, a six-cylindered arrangement, also with surface condensers.

Neither of these vessels have as yet been fully tried, the results, however, being anxiously looked for by engineers.

Considering the nature of these three plans, which, with the exception of the trunk engines, involve considerable complexity, the trunk and three cylinder arrangements being moreover single expansive engines it is very doubtful if the results can be altogether satisfactory; and certainly cannot be so far so as to warrant experiments stopping at the point at which they have now arrived. Trials should at least be given of such other arrangements as appear to likely to give favourable results.

The double-expansion end-to-end cylinder engines proposed by the author, in 1855, for ships of war, have now been very ably worked by Messrs. J. and G. Rennie, and it is understood have been favourably reported upon by the inspecting engineer of the Admiralty, who was instructed to examine them; an opportunity will shortly be afforded of testing their suitability for her Majesty's ships; the success of the principle of double expansion being already fully established, and Messrs Rennie being prepared to guarantee to the Government that the consumption of fuel shall not exceed 2 to $2\frac{1}{4}$ lb. per indicated horse power per hour, or half the ordinary consumption. To the general introduction, however, of so radical a change in the construction of marine engines for the ship of the Royal Navy, a thorough conviction of the importance of economising the fuel seems essential, and it is hoped this will be found to have been somewhat promoted by the present paper.

ABSTRACT OF AN INVESTIGATION ON THE EXACT FORM AND MOTION OF WAVES AT AND NEAR THE SURFACE OF DEEP WATER.

By William John Macquorn Rankine, C.E., LL.D., F.R.SS. L, & E., &c.

The following is a summary of the nature and results of a mathematical investigation, the details of which have been communicated to the Royal Society:—

The investigations of the Astronomer Royal, and of Mr. Stokes, on the question of straight-crested parallel waves in a liquid, are based on the supposition that the displacements of the particles are small compared with the length of a wave. Hence it has been very generally inferred that the results of those investigations, when applied to waves in which the displacements are considerable, as compared with the length of wave, are only approximate.

In the present paper, the author proves that one of these results,—viz., that in very deep water the particles move with an uniform angular velocity in vertical circles, whose raddii diminish in geometrical progression with increased depth; and, consequently, that surfaces of equal pressure, including the upper surface, are trochoidal, is exact for all possible displacements how great soever.

The trochoidal form of waves was first explicitly described by Mr. Scott Russell; but no demonstration of its exactly fullfilling the cinematical and dynamical conditions of the question has yet been published, so far as the author knows.

In a *Manual of Applied Mechanics* (first published in 1858), the author stated that the theory of rolling waves might be deduced from that of the positions assumed by the surface of a mass of water revolving in a vertical plane about a horizontal axis; but as the theory of such waves was foreign to the subject of the book, he deferred until now the publicalion of the investigation on which that statement was founded.

Having communicated some of the leading principles of that investigation to Mr. William Froude, in April, 1862, the author was informed by that gentleman that he had arrived independently at similar results by a similar process, although he had not published them. The introduction of Proposition II. between Propositions I. and III. is due to a suggestion by Mr. Froude.

The following is a summary of the leading results demonserated in the paper:—

Proposition I.—In a mass of gravitating liquid, whose particles revolve uniformly in vertical circles, a wavy surface of trochoidal profile fulfils the conditions of uniformity of pressure; such trochoidal profile being generated by rolling on the under side of a horizontal straight line, a circle whose radius is equal to the height of a conical pendulum that revolves in the same period with the particle of liquid.

Proposition II.—Let another surface of uniform pressure be conceived to exist indefinitely near to the first surface; then, if the first surface is a surface of continuity (that is, a surface always reversing identical particles), so also is the second surface. Those surfaces contain between them a continuous layer of liquid.

Corollary.—The surfaces of uniform pressure are identical with surfaces of continuity throughout the whole mass of liquid.

Proposition III.—The profile of the lower surface of the layer referred to in Proposition II. is a trochoid generated by a rolling circle of the same radius with that which generates the upper surface; and the tracing-arm of the second trochoid is shorter than that of the first trochoid by a quantity bearing the same proportion to the depth of the centre of the second rolling circle below the centre of the first rolling circle, which the tracing-arm of the first rolling circle bears to the radius of that circle.

Corollaries.—The profiles of the surfaces of uniform pressure and of continuity form an indefinite series of trochoids, described by equal rolling circles, rolling with equal speed below an indefinite series of horizontal straight lines.

The tracing-arms of those circles (each of which arms is the radius of the circular orbits of the particles contained in the trochoidal surface which it traces) diminish in geometrical progression with an uniform increase of the vertical depth at which the centre of the rolling circle is situated.

The preceding propositions agree with the existing theory, except that they are more comprehensive, being applicable to large as well as to small displacements.

The following proposition is new:—

Proposition IV.—The centres of the orbits of the particles in a given surface of equal pressure stand at a higher level than the same particles do when the liquid is still, by a height which is a third proportional to the diameter of the rolling circle and the length of the tracing-arm (or radius of the orbits of the particles), and which is equal to the height due to the velocity of revolution of the particles.

Corollaries.—The mechanical energy of a wave is half actual and half potential; half being due to motion and half to elevation.

The crests of the waves rise higher above the level of still water than their hollows fall below it; and the difference between the elevation of the crest and the depression of the hollow is double of the quantity mentioned in Proposition IV.

The hydrostatic pressure at each individual particle during the wave-motion is the same as if the liquid were still.

Friction between a Wave and a Wave-shaped Solid.

In an Appendix to the Paper is given the investigation of the problem, to find approximately the amount of the pressure required to overcome the friction between a trochoidal wave-surface and a wave-shaped solid in contact with it. The application of the result of this investigation to the resistance of ships was explained in a Paper read to the British Association in 1861. The following is the most convenient of the formulæ arrived at. Let w be the heaviness of the liquid; f, the co-efficient of friction; g, gravity; v, the velocity of advance of the solid; L, its length, being that of a wave; z, the breadth of the surface of contact of the solid and liquid; β, the greatest angle of obliquity of that surface to the direction of advance of the solid; P, the force required to overcome the friction; then

$$P = \frac{f\,w\,v^2}{2\,g}\,L\,z\left(1 + 4\,\sin.^2\beta + \sin.^4\beta\right)$$

In ordinary cases, the value f for water sliding over painted iron is ·0036. The quantity $L\,z\,(1 + 4\sin.^2\beta + \sin.^4\beta)$ is what has been called the "augmented surface." In practice $\sin.^4\beta$ may in general be neglected, as being so small as to be unimportant.

ON THE ERIE EXPERIMENTS ON STEAM EXPANSION BY U.S. NAVAL ENGINEERS.

By Samuel McElroy, C.E.

(*Continued from Page* 230.)

When we examine another very important detail of method adopted in these experiments, viz., as to the measurement of coal consumed, we find it also inaccurate and unsatisfactory. This the printed explanation makes sufficiently plain; for when we are told that the notes for each experiment were commenced "with average fires" in the boilers, and that the fires were made, at the close, "the same as at the beginning, *as nearly as could be estimated*," we understand at once that the Board only weighed what coal was used during the actual term of any trial, and guessed at the state of the boilers at its commencement and the end. The precise quantity of coal which produced the recorded number of engine strokes was not weighed. For that essential particular, the board asks us to accept its estimate, and this admission is in itself fatal to any claim of accuracy otherwise presented. Anybody can guess, but it belongs to experimenting engineers to measure and rigidly determine every detail, and especially so important a detail as the coal account, on which all the calculations of results depend. So long as it is easy to determine this account in experiments of this class, beyond any question, we are not prepared to accept any explanation or any apology for its omission. Those who have had frequent occasion to probe these processes, are not to be told that the absolute state of a boiler fire can be determined by its appearance, or its level, or the water level, or the steam gauge; for we know by the results of frequent analyses, that these features may be identical where there is a diference of fifty per cent. in absolute efficiency. Nor can we yield the professional rule in this case, which refuses to accept opinions and estimates where actual quantities are at issue. With the coal account in this state for each experiment, it is impossible for this board to claim that it has demonstrated anything. In entering voluntarily the field of estimate and conjecture, it submits to the "theoretical considerations" it claims to have overthrown.

Farther, in what way are we to reconcile this assumed process with the 1st and 2nd experiments? At the close of the latter, the "average fires" represent a combustion of 3·79lbs. per square foot of grate, while at its commencement, which also marked the close of the 1st experiment, the rate then represented is 6·28lbs. per square foot. There can be but one conclusion in a case of this kind, and it is not very creditable to the discretion of this board in matters of judgment and opinion. Not only is the accuracy of the coal account involved here, but the per centage of ashes, the boiler evaporation, the horse-power, and the resistances.

In experiment No. 5, at $\frac{7}{10}$ths cut-off, the coal account is credited with 18·53 per cent. of refuse, while No. 7, at $\frac{4}{45}$ths cut-off, is credited with but 6·99 per cent., which is not exceeded in any other experiment, none of them agreeing as to this per centage. In No. 5, a different variety of coal was used from Nos.

1, 2, 4, and 7. But is it to be inferred from all these discrepancies that the coal varied so much in quality, or that the system of measurement was defective in accuracy? Under such circumstances, which is the most likely to be true? Two important conditions of the measurement were guessed at; the third only was determined.

We are disposed to concede to this report the merit of deep and abstruse argument. After looking over it very carefully, when it first came to hand, in some bewilderment as to what it did really assert, we endeavoured to find some one place where a clear and unmistakeable conclusion was presented, and failed in discovering anything more definite than the quotation with which we commenced this paper. But in those brief sentences, strange contradictions occur. They begin by admitting a gain with two-fifths cut off; they assert a loss at one-quarter, a loss which we might assume to be referred to full travel, if one-sixth was not immediately presented as such measure. And yet, a page or two back, we are told that if "the proper corrections could be made for the difference of cylinder temperature due to the different measures of expansion, it would doubtless be found that the economical result obtained when cutting off at seven-tenths, is not exceeded when cutting off at any less fraction."

It is not an easy matter, therefore, to pass from general questions of principle and method to a discussion of absolute results, so many different ones having been obtained. The general argument of the report is against the use of expansion at all. The summary of all the allowances, assumptions, and equivalents in table No. 2, ranges the "economic result in net horse-power" with $\frac{4}{45}$, $\frac{1}{6}$, $\frac{11}{12}$, $\frac{1}{4}$, $\frac{3}{10}$, $\frac{7}{10}$, $\frac{4}{9}$ths cut-off in order of precedence, while the economic power in "pounds of steam per horse-power per hour," ranks them $\frac{4}{9}$, $\frac{7}{10}$, $\frac{3}{10}$, $\frac{1}{4}$, $\frac{11}{12}$, $\frac{1}{6}$, $\frac{4}{45}$ths cut-off, which exactly reverses the order. Precisely what conclusion the board really reached does not appear in the report; while its argument rejects expansion, its tables confirm it in part, in instances which contradict its explicit assertions.

In table No. 1, the order of results for the "pounds of combustible" per horse-power, is $\frac{1}{4}$, $\frac{4}{9}$, $\frac{7}{10}$, $\frac{3}{10}$, $\frac{1}{6}$, $\frac{11}{12}$, $\frac{4}{45}$ths cut-off.

Passing from this troublesome triangular tabular duel, we may take up the assertion, that "the economy of cutting at one-sixth or four forty-fifths is considerable less than with steam used absolutely without expansion," for the purpose of tracing the argument of the report.

Assuming that the "data" given in our synopsis of table No. 1 were rigidly and accurately obtained, we cannot compare the results of one-sixth cut-off with full steam travel, because the latter was not tested; but taking eleven as an approximation, the horse-power per pound of coal is in favour of the former as 5·53 to 4·58, although there is a loss of ·9in. in vacuum.

In this case, the horse-power is determined by the mean pressure of the indicator cards, the revolutions, and the coal account in the usual way.

But the board decides the propriety of making certain corrections to these "data."

The per centum of refuse in the coal account varies in each trial. It is as low as 5·75 and as high as 18·53. For one-sixth cut-off it is 5·75, and for eleven-twelfths it is 6·83. The latter is therefore credited with the difference. Having already expressed our opinions of the special accuracy of experiment No. 2, which cuts-off at $\frac{1}{6}$th, we need not reiterate obvious objections. It is enough to suggest that if, in experiments as deliberately conducted as these, the same boiler work could not be realised in similar kinds of coal, a principle under investigation ought not to be charged with the difference, and also, that it is not perfectly clear that the difference between ashes in weight and that of the coal producing them, represents the absolute evaporative valve of the coal. The manner in which the coal is burnt has something to do with that point.

There is a difference of vacuum against No. 2 which we do not find credited.

Experiment No. 7 ($\frac{11}{12}$ths) shows an average back-pressure in the cylinder of 4·2lbs., while No. 2 shows but 2·8lbs. In all these trials, it appears that expansion reduces back-pressure by a descending series, except a change in No. 7. But, without accepting this *experimentum crucis* of the condensation argument, the board decides that back-pressure must be assumed at a common standard which it accordingly takes at 2·7lbs. from No. 3. Consequently, the mean pressure of No. 2, which is 13·6lbs., is to be charged with the standard of 2·7, while that of No. 6, at 29·8lbs., is credited with the difference between 4·2 and 2·7. This varies the relative horse-power, and is highly creditable to the treatment of the questions at issue.

The board then enters into a long argument to show that the "net horse-power applied to the water by the paddles" is the only correct basis of calculation of work, rejecting the work which is done by the piston. This involves a difficulty, slight, however, to ingenious men. After the trials are over, they spin the wheels around at various speeds, and determine by indicator cards the exact "pressure due to the friction and resistance" of the organs of the engine, which they establish at the common standard, for all loads and all speeds, of 2·1 lbs. per square inch. The mean pressure of No. 7 bears this charge much more easily than that of No. 2.

In this case, the expansion is charged with the interesting fact that the friction of an engine, and especially an engine paddling water, is constant at all speeds, and under all loads. If the velocity varies in the proportion of 11·17 to 20·61, and the load varies in the proportion of 13·6 to 29·8, the effort is precisely 2·1 lbs. per square inch in each case. It is 15·4 per cent. in one, and 7 in the other. Morin, Weisbach, and others, have therefore been convicted of many "fallacious theories" on this matter of frictional and fluid resistance. Their results are entirely reversed.

And yet, granting all these equivalents, when we reach the last point of calculation, we find that the experimental result in net horse-power for No. 6 is 1000, and for No. 2 is 1065. It is not true, then, that it is better to cut off at $\frac{11}{12}$ths than at $\frac{1}{6}$th, and, by consequence, it is not true that it is still better to follow full stroke. The summary of the report falls to the ground: *vox et præterea nihil.*

But the economy of full steam, we are told, is comprehended in the use of smaller engines, which are to save first cost, space, and repairs. In what respect, except as to the bore of the cylinder, is the *Michigan's* engine to be reduced? The wheels, shaft, cranks, and connexions, condenser, air-pump, &c., at one end must retain their present strength and size, and at the other end the boilers must be as large and require as large coal bunkers. In reducing the bore of the cylinder, it would be improper to reduce the side-pipes and valve-chests, and the piston-stroke should not be shortened. Nothing, then, can be saved, except a few pounds of cast iron, a few bolts, and a little wrought iron and rubber. The modified engine will go to sea like one of the fashionable belles denounced in medical journals: the head, arms, and lower limbs fully developed, but the seat of vital action laced and compressed beyond all reason and contrary to natural health. If the Board holds that the friction of an engine is independent of its load, it may also hold that "wear and tear" is equally independent: otherwise the working parts save nothing in repairs or liability to fracture.

Again, we are informed in the report, that the pressure defined by the law of Mariotte, as derived from "abstract considerations," and illustrated by indicator cards, is "so specious, and apparently so conclusive (as a promise of economy in expansion), that up to within the last one or two years, the assumption passed unchallenged by the engineering profession; but the Erie experiments claim to have overthrown this specious assumption.

We have analysed these experiments sufficiently to show that, however improper their *modus operandi*, their results do not prove any loss in power. Let us now examine the theory of a loss which is asserted and not demonstrated.

It is asserted that, in the case of full steam travel, as the piston gradually uncovers the surfaces previously exposed to the exhaust, a condensation takes place; so that, at the end of the stroke, the cylinder surface is covered with a film of water at exactly the boiling-point, due to the pressure of its steam charge. When the exhaust valve now opens, this water evaporates, and the value of its heat is lost in the condenser.

When the cut-off is used, the condensation goes on in the same way, except that the film of water condensed before the valve closes commences to evaporate as the pressure falls, and re-evaporation takes place on the surface of the cylinder throughout the stroke, instead of after the return stroke, cooling down the surface during the whole time of expansion movement. This loss is said to be of a very serious character, and, like that due to full travel, must be made up at every new stroke.

This Board is twice mistaken. First, in assuming that engineers have depended on realising the absolute results of Mariotte's law, without the modifications due to conditions of practice; and, second, in assuming the merit of discovering this process of condensation.

The losses due to imperfect combustion and evaporation, foaming, condensation in steam passages, leakage of valves and joints, and back-pressure, certainly have been fully admitted, and are always anticipated. And precisely as far as these may, in practice, modify the results of an absolute law, our confidence in the law itself need not be affected. Imperfections in applications, instead of inclining us to this monstrous argument, which would dispense with expansion because some of its benefits are vitiated, should only prompt us to the construction of more perfect machinery, by which the law itself may have a better development. No single portion of this report, no result attained, disproves the correctness of the law, and its whole argument, rightly understood, vindicates expansion against imperfect mechanism, imperfect management, and prejudiced experts.

As long ago as 1782, the master mind of the steam engine, in proposing to cut off at one-quarter, was discussing the effects of this principle of condensation. Since that time, all the way down, engineers have taken ordinary and extraordinary precautions against it. They have built fires under their cylinders, they have placed cylinders within cylinders, they have built around them brick-work houses, they have exhausted the varieties of non-conducting materials, in all kinds of felting and jacketing. There is not anything new, then, in this discovery of condensation, or the apparently neglected operation of external radiation.

Nor is it true that experiments on the assumed losses by condensation are at all novel. The author of the "Precedents" only provoked a smile when he congratulated himself as the first to compare the tank with the indicator. The idea is not at all patentable.

Nor is it anything of a novelty that comparisons between the tank and indicator should, on account of imperceptible boiler waste, foaming, steam-pipe, and cylinder condensation, valve leakage, &c., show a per centage of difference depending on the comparative protections used against these losses. Nobody disputes it. Everybody anticipates it.

So fully, in fact, are engineers advised on this point, that when any experiment is presented to them, no matter by whom conducted, which claims to have found but 2·91 per cent. loss between the tank and indicator, they respectfully deny its accuracy. It is impossible to avoid a greater loss in the boiler itself, and between the boiler and steam-chest, and at the valves, as well as in the cylinder. Take the case actually presented. The boiler pressure for experiment No. 6 is 36lbs. and at the cylinder valve we have 34·9, or a little over 3 per cent. in that item alone. In No. 7, the boiler pressure is 36·9 and the pressure at the valve 34·8lbs., or 5·7 per cent. less, in this respect alone. No credence whatever, then, can be given to the calculation, which sums up all the losses in $\frac{11}{12}$ths steam travel at 2·91 per cent., finding them for $\frac{4}{45}$ths, 37 per cent. The indicator cards given for experiment No. 6 show a final pressure of 29·3lbs., whereas, with an initial pressure of 34·8, it should not have been less than 31·9. Here is a loss of 2·6lbs., to be accounted for, or about 8 per cent., making a total for but two items of all those in force of 11 per cent., which the indicator cannot show. When we turn to the expansion card of No. 2 and No. 7, on the other hand, we find that the final pressure in the first case is 7·8lbs., when it should not be over 5·71, being 2·09lbs., or 37 per cent. in excess; in the second case it is 5·9lbs. instead of 3·02, being 2·88lbs., or 95 per cent. in excess. This excess the indicator has accounted for, as well as the tank, but the book-keeping of the Erie Board brings expansion still in debt.

Granting, for the moment, the correctness of the theory of condensation we have quoted, as an argument against expansion, when we come to compare it with the losses due to any condition of operation, what is its practical amount? Expanding or not, at every stroke the cylinder surface is exposed to the action of the exhaust, which must be much more formidable than the action of the steam charge, no matter what its conditions. Whatever this loss may be, is it not true that its effect, after the engine has attained uniform action and after the main valve closes, is confined entirely to the particular charge of steam enclosed by the valve in the cylinder; and, inasmuch as *pressure, temperature,* and *volume,* are rigid measures, one of the other, how can it be denied that the indicator is a correct index of all such effects? As the indicator card does not in reality measure the operation of any given stroke on each side of the piston, but combines the steam travel of one stroke with the exhaust travel of the succeeding one, it is also a measure in any special steam travel of the effects of its precursor; and, until it can be proved that the volume and temperature of the steam charge can be changed without affecting its pressure, pressure must be taken as a direct index of each. We have looked in vain through this report for any positive denial of this principle. At the very close of the elaborate discussion of losses by condensation, it is stated that, "if there be any portion of the stroke during which the steam loses the form of vapor, a dynamic effect measured by that portion and the *wanting pressure,* is lost." It is beyond reason, then, to claim that the indicator will not measure any such "wanting pressure."

This theory of special loss by condensation, in expanding, must be tested by its evidences. Various experiments have been made at different times and by different authorities, with different results. Pambour, on one side, determines a slight loss, while Pole invariably discovers a gain. We have notes on careful experiments on an engine working generally under one-fifteenth cut-off, where the sum total of all loses is 23·4 per cent. In other cases we have found it 16 per cent. As a matter of testimony by experiment, then, the "data" of the Board must face numerous results by no means "fallacious," or "specious," or "purely theoretical."

To return to the argument of the indicator cards:—In experiment No. 6, there is a loss in final pressure of 8 per cent., and in back-pressure, as referred to *mean pressure,* there is a loss of 14 per cent., and of 12 per cent. in *initial pressure.* In experiment No. 2 there is an excess in final pressure of 37 per cent. beyond that due to the initial steam and expansion, while the back-pressure is 20·6 per cent. of the mean pressure, and 8·2 per cent. of the initial. In experiment No. 7, the excess of final pressure is 95 per cent., the back pressure being 42 per cent. of the mean, and 10·9 per cent. of the initial. Certainly there is no argument in such a state of facts as to losses in the cylinder by expansion, but there is a most fatal argument against the parade of accuracy, and perfect machinery, and valves which could not possibly be supposed to leak.

The experiments, as to back-pressure, confirm a point of simple demonstration, viz.: that the reduction of steam volume per stroke involves a reduction of back-pressure, as referred to initial pressure, and that this item, in comparing similar volumes doing the same work, is not increased by expansion. All the subtle deductions of the report on this point are incorrect, being disproved by its own results. As to economy of work, it appears that there is an absolute excess of pressure at the highest rate of expansion, and nearly double the final pressure due to the Mariotte law, which is a waste of power and steam to an enormous extent, and is chargeable to leaky valves, being an item of credit to the expansion account. When we remember that in boiler priming the results in waste are formidable against full steam travel; that this matter of condensation as applied to expansion *per se* and compared with other palpable losses can have but little effect; that the whole course of these experiments tends to prevent the true illustration of economy in expansion, and does not assert the opposite in result; we may well be content to rest the examination of results at this point. If the Eric Board, in expanding $\frac{4}{5}$ths, burned over 6lbs. of coal per horse-power per hour, we may readily accept the testimony of those engines which, at the same expansion, burn 2lbs. per horse-power.

A certain mechanical principle underlies and controls the whole question of expansion, although its connexion is not commonly recognised. A principle which belongs to the primitive formations of all engineering theory and is indissolubly united to the very elements of motion. Our allusion to it involves a slight historical discussion.

The writer is in error in two respects; first, by the fact that Hornblower preceeded Watt six years in the application of expansion as a source of economy, and second, that Watt's original application of the cut-off was made in view of the great principle to which we allude, viz: the effect of the *mass of an engine in motion.* Nor is the speculation as to Watt's unpublished experiments on expansion leading him to adopt a steam travel of three-quarters probable, as he made the mistake of the Erie Board and vitiated the results within his reach by using too low pressure. He proposed in 1782 to cut-off at one-quarter. Trevithick in 1806 apprehended the question of economy much more fully, using steam at 40lbs., and proposing to build an engine to cut-off at less than one-sixth. And since that time, the whole Cornish school, instead of confining itself to this standard, has carried the grade of expansion in some cases to one-twentieth, not for purposes of experiment, but for regular duty. It is a very great mistake to suppose or to assert that, "until quite recently, it was the exception, and not the rule, to find new engines cutting off at less than one-half."

But without pausing here to sustain a very simple matter of record, we refer again to the fact, that when the genius of Watt superseded the atmospheric engine and used steam as a driving power, it also comprehended an inevitable law of motion, which demanded the application of the cut-off as a mechanical necessity, in advance of any idea of economy. We take an impregnable position, then, based on absolute principles, when we assert that the cut-off is an appurtenance which bears to every engine in full motion a relationship entirely independent of any question of economy, although this is a natural sequence, and that the idea of assuming full steam travel as a basis of comparative mechanical action is a misapprehension of engine duty.

The argument on this point is sufficiently clear in reference to all bodies in motion which have weight. To overcome the inertia of an engine, a certain surplus pressure must be applied to the piston, which corresponds with initial pressure, and is exceeded at no after point of the stroke. The mass being thus put in motion by charging it with surplus power, it is a mechanical absurdity to continue the initial pressure any farther than will suffice to complete the stroke by virtue of the surplus power imparted at the commencement. In the general application of this law, there is no distinction between single-acting and fly-wheel engines; mass in motion characterises both.

It is an absolute necessity, then, in every engine, that the power necessary to complete its stroke properly, must be imparted to it in excess at an early period of such stroke; and inasmuch as the whole experience of the steam engine in practice abundantly confirms the theoretical conclusion that this surplus power may be exerted at a very early point of motion, this disposes of the expansion question, not only as to mechanical effect, but as to economy. For all the fine drawn arguments on condensation and re-condensation are of very little consequence to the mass which is by this time distributing its excess of power.

Viewed in this light, the doctrine of expansion divests itself of all incumbrances. We come back again to the principle of maximum useful effect. There is a given velocity to be imparted to a given load at the start. If a steam travel of four feet under ten pounds pressure will do it, who is to assert that a travel of one foot under forty pounds pressure will not do it equally well—better in fact, and much more cheaply? No experimental philosophy can prevail against a plain mechanical law like this, and certainly no such experiments as those we have here discussed. On the contrary, the most extensive, severe, laborious research, by the first men of the age, has brought out this law "seven times refined" for the benefit of the world. So long as we know that the maximum velocity of motion can be imparted to an engine before it reaches the half-stroke, we decide the fallacy of any argument which prescribes any later point of cut-off; and we also decide that the only limit to economy of steam by expansipn is to be determined by the practicable conditions of such initial motion, and the practicable perfection of construction.

NOTICES TO CORRESPONDENTS.

C. H. (Liverpool),—Will be answered through the post.

J. R.—Many thanks for your suggestions. The ideas are good. We shall be glad to hear further from you upon the several subjects.

A. N. (Kirkcaldy).—In the absence of either models or drawings, we are not in a position to arrive at a conclusion as to the utility and value of your proposed arrangements. We trust, however, that you will succeed in your efforts, as there is great room for improvement in the particular class of engines to which you refer.

G. S. (Victoria).—Mr. J. J. Berkley, M. Ins. C.E., and Engineer-in-Chief, in India, of the Great India Peninsular Railway, died at Sydenham on the 25th of August last. You will find a brief memoir of his life in the obituary of The Artizan of October.

Marine Engineer.—You will find illustrations of the rotary steam boiler in The Artizan of September.

O. S.—We answered you by post, and trust the information was to the point.

RECENT LEGAL DECISIONS

AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

Under this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

Warranty of a Sewing Machine.—Blackburn v. Carter.—This case came on for trial at the Salford Court of Record, on the 8th ult. The case excited some interest amongst manufacturers and workers of sewing machines, and occupied upwards of twelve hours in the hearing. The plaintiff was a butter merchant at Rochdale, and the defendant a sewing machine manufacturer, of the same place. The action was to recover £12 10s., for breach of warranty. The plaintiff's evidence, which was supported by three other witnesses, was that he had bought a "No. 2 Thomas's" machine from the defendant, in November last, for £12 10s., the defendant taking a "Lancashire" machine in exchange, for £5, as part payment. He explained to defendant that he wanted the machine to do the finer description of ladies' dress making, such as sewing muslins, lawns, silks, and satins. The defendant replied that his machine was just the one for the work; it was equal to Wheeler and Wilson's, or even to the "Great Thomas's," and, in fact, he would warrant it to sew properly anything "from muslin to leather," and he would engage to keep it in good working order for twelve months; it should be a good and perfect machine. Accordingly the machine was purchased, but it was found that it would neither sew fine work nor any other work properly. The defendant made some alterations in it without improving it, and, in March, he declined to have any more to do with it, hence the action. Two machine makers were called, who stated that they examined the machine, and that it was not fit to do any kind of work properly, and could not be made to do fine work at all. In fact the No. 2 machine was not suited for fine work. The defendant alleged that the only warrants he gave were that the machine would be fit for general dressmaking and domestic purposes, and that the machine supplied was fit for such purposes, before it had been tampered with by the plaintiff. It was a good and perfect machine. In cross-examination, however, he admitted that he had made alterations in the machine, such as altering the tension, &c. Several scientific witnesses were called in support of the defendant's case, and stated that the machine could be made to do its work well with an outlay of about 8s. They considered that the defendant's requiring it to be remedied arose from the machine being tampered with by non-competent workmen. They all said that the No. 2 was sold more frequently than any other machine for general domestic purposes. Mr. Pope, for the plaintiff, contended that the contract to supply a machine suited to do fine work was fully made out, and if that was so it was evident, even from the defendant's case, and the contract had not been fulfilled. The fact of his having made alterations in the machine was sufficient to show that he did not consider it a perfect one. After a careful summing up by the judge, the jury returned a verdict for the plaintiff for the full amount claimed. In the course of the case, it was elicited that the so-called "No. 2 Thomas's" machine, was not really Thomas's at all, but a close imitation of his patent.

IMPORTANT TO JOINT-STOCK COMPANIES.—The House of Lords has decided a case arising out of the affairs of the Edinburgh and Glasgow Bank, upon an appeal from a judgment of the Court of Session in Scotland—the case of "Cullen *v.* Thomson." The judgment of the House, as delivered by the Lord Chancellor and Lord Wensleydale, while confirming the judgment of the Court below as to the responsibility of directors, goes much further, and lays down in the broadest form possible the following propositions of law:—"1. That where directors of a joint-stock company issue false and fraudulent reports to the public, and the manager, secretary, and other officers of the bank supply the detailed statements for such reports, knowing them to be false, and that they are to be used for purposes of deceit, and a third party, acting on such reports, purchases shares in the company and suffers loss thereby, each of the officers of the company who knowingly assisted in the fraud is personally liable to such third party for the loss caused by such misrepresentations in the report, though the report was signed only by the directors, and not by the subordinate officers. 2. The manager and secretary of a joint-stock bank as well as the directors are servants of the shareholder, and the manager and officers are equally liable for fraudulent reports, though not signing their names thereto; for the public in such cases give credit to the officers of the bank as much as to the directors. 3. A servant who joins with and assists his master in the commission of a fraud is civilly responsible for the consequences, though his concurrence is unknown to the party injured, for all directly concerned in the commission of a fraud are principals."

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts (for which we are chiefly indebted to the *Chemical News*), Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

THE STEPHENSON MONUMENT.—The monument to George Stephenson, the railway engineer, was inaugurated with every demonstration of popular respect, at Newcastle-on-Tyne, on the 2nd ult. It is erected in Neville-street, opposite to the Central Railway Station, and is a striking work of art. It consists of a statue of the great engineer by Mr. Lough, together with emblematical figures representing a blacksmith, a plate-layer, a pitman carrying the famous "Geordie" lamp, and an engine-driver. It is extremely effective, and the statue of Mr. Stephenson is considered, by his old acquaintances, to be extremely life-like. The day, upon the whole, was fine, and the proceedings commenced by ten workmen in Messrs. Stephenson and Co.'s, and the other large factories in this town and Gateshead and the neighbourhood, with the Odd Fellows, the Foresters, and other friendly societies meeting in the parade ground, and marching in an immense procession to the Town Hall, where they joined the executive committee, the members of the Institution of Civil Engineers, mechanical engineers, mining engineers, the presidents and committee of the various ecclesiastical societies in the town, the chairman and directors of the North Eastern and other local railways, the mayors of this and neighbouring boroughs, the local Members of Parliament, and foreign consuls, the Coal Trade Association, &c., who proceeded in an immense body to the inauguration.

PETROLEUM ACT.—This Act came into operation on the 1st ult. Petroleum includes any product thereof that gives off an inflammable vapour at a temperature less than 100° Fahr. Ships carrying petroleum shall conform to the regulations made by the harbour authorities. Not more than 40 gallons of petroleum shall be kept within 50 yards of a dwelling house, or of a building in which goods are stored, except in pursuance of a licence given by the Court of Lord Mayor and Aldermen of the City of London; by the Metropolitan Board of Works for the other parts of the metropolis; by the council of any city or borough in England or Ireland; by the trustees or improvement commissioners under local Acts; by the town council or police commissioners in any burgh or place in Scotland; by harbour authorities for any harbour; by justices in petty sessions assembled for any other place in England and Ireland, and two justices of the peace for the county in Scotland for any other place in Scotland. Any petroleum kept in contravention of the Act shall be forfeited, and, in addition thereto, the occupier of the place in which such petroleum is kept shall incur a penalty of not exceeding £20 per day for each day which petroleum is kept in contravention of this Act. And all forfeiture or penalties may be enforced in England and Ireland upon summary conviction before two justices, and a moiety thereof shall belong to the informer, unless he is a servant of the person informed against. And in Scotland forfeitures and penalties may be enforced, upon summary conviction, at the instance of the procurator-fiscal, either before sheriffs, justice of the county, or a police magistrate of the burgh in which the offence is committed, and the offender may be imprisoned, for a period not exceeding three months, until the same be paid. And petroleum may be searched for in the same manner in which gunpowder may be searched for under the recent Act relating to search for gunpowder, and its provisions are to be incorporated with this Act, and construed as if the word "gunpowder" therein included "petroleum," as defined by this Act.

THE PATENT OFFICE.—Mr. Woodcroft has at length obtained permission from the Board of Works to appropriate to the purposes of the Patent Office the large Government warehouse immediately contiguous to it. The new rooms have a floor area of upwards of 7000 square feet, and great improvements will be made in the present offices.

A LONDON PERMANENT EXHIBITION.—A prospectus has been issued of the Universal Club and Permanent Exposition Company, with a capital of £100,000, in shares of £5 each. The proposal is to establish a permanent mart in London for the exhibition of samples, patterns, and models, and to secure for the purpose certain premises in Cannon-street which are considered to be peculiarly eligible.

PRESERVING SHIPS' BOTTOMS.—In order to test the relative value of certain compositions for preserving the bottoms of iron ships, the Lords of the Admiralty have given orders to use the bottom of the iron steam tank vessel *Minx*, at Plymouth, for that purpose. A portion of 40ft. broad, extending from the bends to the keel, will be divided into four sections of 10ft. each, on which will be applied the compositions of Mr. Hayes, the Queen's chemist, Portsmouth; Mr. Finnemore, chemist, Plymouth; Mr. Elsworth, and Mr. Edwards. The *Minx* is employed supplying the Channel fleet with water. At the end of about three months her condition is to form the subject of a special report by some competent Government authority.

DISEASES PRODUCED BY FUMES OF ZINC.—Dr. Greenhow, in a paper lately read before the Royal Medical and Chirurgical Society, stated that this disease had first fallen under his observation during a brief holiday visit to Birmingham in the autumn of 1858, and he had subsequently been able on several occasions to investigate its history and causes in Birmingham, Wolverhampton, Sheffield, and Leeds. The symptoms have some resemblance to an imperfect paroxysm of ague; but they differ it from in this respect, that the paroxysms occur irregularly and are distinctly traceable to exposure to the fumes of deflagrating zinc. The attack commences with *malaise*, a feeling of constriction or tightness of chest, sometimes accompanied by nausea. These always occur during the afterpart of a day spent in the casting-shop, and are followed in the evening or at bed-time by shivering, sometimes succeeded by an indistinct hot stage, but always by profuse sweating. The sooner the latter follows the setting in of the cold stage the shorter and milder is the attack, and the less likely is the moulder to be incapacitated for work on the following day. Headache and vomiting frequently, but by no means always, accompany the attack, which at the worst is only ephemeral; but the attacks are sometimes of frequent occurrence. Persons who have but lately adopted the calling, or who only work at it occasionally, and regular brass founders who have been absent from work for a few days, are more liable to suffer from this disease than those who work at it continually. The men themselves attribute this disease to inhaling the fumes of deflagrating zinc, and there can be no doubt that their opinion is correct. The remedy is to work in large, well ventilated brass foundries, and to employ a draught to conduct the zinc fumes out by the chimney.

THE COAL TRADE TO THE METROPOLIS.—The returns made of the quantity of coal conveyed to the metropolis by railway, canal, and sea-borne, will show a very marked diminution. For the present year, 755,850 tons 14 cwts. of coal have been carried by railway, against 958,713 tons 11 cwts. for the corresponding period of 1861, or a decline of 182,862 tons 17 cwts. The canals show 6722 tons, against 11,815 tons 15 cwts., or 5093 tons 15 cwts. less this year than last. The sea borne coal has declined 53,072 tons, the quantity for the present year being 1,932,581 tons, as compared with 1,985,653 tons for the first seven months of 1861. For July last the London and North-Western Railway; have conveyed 50,029 tons 1 cwt.; the Great Northern, 25,066½ tons; Midland, 14,588 tons Eastern Counties, 12,256 tons; Great Western, 7217 tons; Chatham and Dover, 243 tons 11 cwts.; Tilbury, London, and Southend, 60 tons—total, 109,455 tons 2 cwts., against 119,677 tons 15 cwts., in the month of July, 1861. The receipts by canal for the last month were 534 tons, against 1690 tons for July, 1861. The importations from Newcastle have been 80,999 tons; Sunderland, 79,724 tons; Hartlepool and West Hartlepool, 57,327 tons; Seaham, 34,959 tons; Middlesborough, 4427 tons; Blyth, 2224 tons; from Wales, 9555 tons; Yorkshire, 3140 tons; Scotch, 1364 tons. Of Duff, 1550 tons; small, 1313; and cinders, 2351 tons—making a total of 269,408 tons, against 290,918 tons for July, 1861.

EXTRAORDINARY RISE OF THE TIDE AT LIVERPOOL.—On the morning of the 17th ult., one of the most extraordinary tidal phenomena occurred on the Mersey, the circumstances presenting most remarkable features, and well worthy the attention of the scientific world. According to the tide table, high water was at twenty-five minutes past five in the morning, previous to which the vessels in the river (of which there was a considerable number), had their heads pointed down the river towards the fort and Rock lighthouse. When the tide turned and was on the ebb, of course their positions were reversed, the vessels pointing with their heads up the river towards Garston and Runcorn. Half an hour after the ebb of the tide had commenced it again began to rise, and so continued until it had attained eighteen inches above high water, the vessels in the river again swinging round with their bows to the entrance of the river, to the great astonishment of all on board the different ships. The phenomenon was witnessed by all the pier head masters and many persons on the different pier-heads, as well as by the boatmen on the river, and has since been the subject of much conversation among nautical men. This double rise of the tide cannot be attributable to the strong N.N.W. wind blowing at the time, and so forcing a large body of water into the Mersey, as there have been frequent gales from the same quarter.

UTILISATION OF WASTE HEAT.—A valuable and ingenious invention has recently been patented by Mr. J. S. Joseph, of Rhostyllan, North Wales; it consists in constructing a large retort built up of fire-brick or other suitable material, and surrounded by an outer shell of the same, so that a space may be left all round the retorts, the ends of the latter passing through the ends of the enclosing structure, and being provided with suitable doors. In order to support the retort, he forms piers of fire-brick or other suitable material underneath the same. He prefers to construct the retort of a catenary, parabolic, or elliptic sectional form, so that the whole of the upper structure shall be in a state of equilibrium, without any material support from the sides, but he also constructs the same in any other suitable manner. This retort oven he employs either for making coke, charcoal, or for any other similar processes. At or near the top of the retort he forms suitable openings, through which the combustible gases formed inside the same by any of the above-mentioned processes pass into the surrounding space. He introduces small jets of atmospheric air both into the space between the top of the retort and the surface of the materials inside the same, as also into the space surrounding the retort, and thus causes the complete combustion of the before-mentioned combustible gases, thereby creating an intense heat, which having access to nearly the whole outer surface of the retort causes the process which is taking place inside the same to be effected in the most rapid and perfect manner. The hot products of this combustion are either allowed to pass away to a chimney, or by preference he employs the same for generating steam in a boiler or boilers for making illuminating gas in retorts, fixed either in the before-mentioned space in the oven, or enclosed in separate chambers, for firing pottery in separate ovens, for heating drying stoves for general purposes, for calcining ores, for burning bricks, or for burning lime in kilns. For each of the above-named processes the hot gases are conducted to the furnaces, kilns, ovens, or stoves through suitable flues, and in order to regulate the heat he forms a communication between the retort oven and a chimney shaft, which communication can be opened or closed at pleasure, so as to allow more or less of the hot gases to escape.

NAVAL ENGINEERING.

AN IRON-CASED SHIP FOR THE TURKS.—The Turkish Government has called upon the Thames Shipbuilding Company, Messrs. C. J. Mare and Co., Messrs. Laird Brothers, Messrs. Samuda, and Messrs. Napier, to furnish them with estimates and plans for a powerful iron-cased screw steamship.

THE "ECLIPSE," 4, screw steam gun vessel, 700 tons, 200 horse-power, was, on the 11th ult., taken out on a trial of her machinery at the measured mile off Maplin Sands. She is fitted with a Griffith's screw, 17ft. pitch, 11ft. diameter. She attained a speed, with full boiler power, of 9·674 knots, the revolutions of her engines being 77. At half boiler power she made 7·639 knots, with 64 revolutions. There was a slight hot bearing, which was kept down by a supply of water, and did not interfere with the ship's speed.

THE "PYLADES," 21, screw steam corvette, 1278 tons, 350 horse-power, which has been undergoing thorough repair at Chatham, was taken out on the 10th ult. for a trial of her machinery at the measured mile off Maplin Sands. She is fitted with Smith's screw, with the leading corners cut off. The pitch of the screw is 20ft., and the diameter 15ft. 9in. An average speed, with full boiler power, of 10·732 knots was attained. The revolutions of engines were 60¾ per minute; pressure of steam, 19; vacuum 26ft. forward, 21ft. aft. A speed of 8·235 knots was attained at half boiler power, with 48¼ revolutions. She turned the circle in 4 min. 20 sec.; half-circle in 2 min. 30 sec., the diameter of the circle being three times the length of the vessel. The wind was easterly, with a force of from five to six, the sea being tolerably smooth.

EXPERIMENT ON THE "JACKDAW" GUNBOAT.—An experiment was, by order of the Lords of the Admiralty, tried, on the 6th ult., in Keyham basin, Devonport, on board the gunboat *Jackdaw*. Pipes of about a foot in diameter have been fitted to the vessel, one on each side, having communication below the water line amidships and at the bows. The ship was lashed about the waist to a buoy, and the valves connected with the pipes having been opened, the force of the steam of the ship's engines was brought on each pipe alternately, so as to drive the water out at the bow, and cause the ship's head to turn in the contrary direction, which is the object of the invention. The experiment was conducted under the superintendence of the officers of the Steam Reserve, and is said to have been successful.

NAVAL APPOINTMENTS.—The following have taken place since our last:—J. Roberts, acting Chief Engineer; R. Hodge, Engineer; J. Cooper and A. Young, First-class Assist. Engineers; and J. A. Dicks, Second-class Assist. Engineer, to the *Barossa;* W. N. Donald, Engineer; J. S. Macfarlane and J. C. Weeks, First-class Assist. Engineers; and J. Mitchell, acting Second-class Assist. Engineer, to the *Eclipse;* W. Castle, acting Engineer; and C. W. G. Chambers, First-class Assist. Engineers, to the *Cornwallis;* T. H. Morgan, acting Engineer, to the *Pembroke;* S. G. R. Knight, confirmed First-class Assist. Engineer, in the *Asia;* J. Hill, Engineer, to the *Cumberland*, for the *Osprey;* H. Cook, Engineer, additional, to the *Fisgard;* H. D. Garwood, First-class Assist. Engineer, to the *Asia*, for tho *Swinger;* W. W. Webber, First-class Assist. Engineer; and W. F. Rowe and W. H. G. Webb, Second-class Assist. Engineers, additional, to the *Fisgard;* C. Dickson, Chief Engineer, to the *Fisgard*, for the *Hector;* E. S. Peach, promoted to acting Engineer, in the *Janus;* R. Bacon, in the *Asia;* H. Pitt, in the *Scout;* J. Lanksbury, in the *Mullet;* G. Lucas, in the *St. George;* A. Wood, in the *Pantaloon;* W. Blamey, in the *Chanticleer;* J. Dearden, in the *Pheasant;* and W. Gibson, in the *Icarus*, promoted to the rank of Engineers; H. Woolley, confirmed as Engineer, in the *Indus;* A. Leitch, acting Second-class Assist. Engineers, to the *Asia*, as supernumerary; W. Hallowell, acting Second-class Assist. Engineer, additional, to the *Indus*, for the *Liverpool;* J. Lee, Chief Engineer, to the *Leopard;* M. Johnson and J. Connor, Chief Engineers, to the *Indus*, for the *Exmouth*, and to the *Cumberland;* T. G. R. Knight and J. F. Moreton, First-class Assist. Engineer; W. Edwards, Second-class Assist. Engineers: and A. Rowe, acting Second-class Assist. Engineers, to the *Leopard;* T. J. Finley, Second-class Assist. Engineer, to the *Indus*, for the *Tilbury;* J. Briggs, acting Second-class Assist. Engineer, to the *Defence;* W. Williamson, Engineer; and J. Babtist, First-class Assist. Engineer, additional, to the *Bacchaule;* A. Moreton, First-class Assist. Engineer, to the *Indus*, for the *Tilbury;* R. Ditchburn, First-class Assist. Engineers, to the *Asia*, for the *Cracker;* F. W. Robinson, confirmed First-class Assist. Engineer; F. H. D. Donnison and B. Grant, Second-class Assist. Engineers, and J. S. Pidgeon and J. W. Nelson, Acting Second-class Assist. Engineers, additional to the *Bacchante;* S. Sheldon, Second-class Assist. Engineer to the *Blenheim;* W. G. Paiga, Acting Second-class Assist. Engineer to the *Hawke;* C. Peal and E. Taylor, Engineers to the *Asia* and *Himalaya* respectively; J. Bannerman, Engineer to the *Leopard;* J. Jolly, promoted to Engineer in the *Adventure;* R. J. Wemyss, Chief Engineer to the *Asia* for the *Curaçoa;* J. Baptist, in the *Bacchante*, promoted to Engineer; C. Alsop, Second-class Assist. Engineer to the *Resistance;* J. C. Grucky, Chief Engineer to the *Burossa;* J. Roberts, Acting Chief Engineer to the *Cumberland*, as Supernumerary; G. Edwards, Acting Second-class Assist. Engineer to the *Trinculo;* H. G. Pilcher, Engineer to the *Asia*, for the *Volcano;* W. Collier, Engineer to the *Asia*, for hospital treatment; A. Clarke, First-class Assist. Engineer to the *Defence;* A. Shoolbread, Acting Second-class Assist. Engineer to the *Indus*, for the *Zephyr;* T. G. Slade, Chief Engineer to the *Barrosa;* G. Griffiths, Engineer, A. Smith, and J. Gray, First-class Assist. Engineers, and A. Bullions, Second-class Engineer, to the *Psyche;* W. A. Elliott, Engineer to the *Blenheim*, for service in her tender; T. Summers, Engineer to the *Asia*, for the *Enchantress;* J. Rice, First-class Assist. Engineer to the *Asia*, as Supernumerary; W. Roberts, First-class Assist. Engineer to the *Indus*, for the *Zephyr;* A. Ritchie, confirmed as Second-class Assist. Engineer; Lawton, First-class Assist. Engineer to the *Indus*, for the *Swallow;* J. Donne, Engineer to the *Indus*, for the *Partridge;* J. S. Pidgeon and J. Stocks, confirmed as Second-class Assist. Engineers.

THE "BLACK PRINCE."—An officer on board this iron-cased frigate, in describing her passage out, says, in a letter, dated the 8th ult., "Our ship answers remarkably well. It was thought these ships were useless as sailers, but we did 7½ knots under canvas alone. The *Warrior* beats us steaming, but it is doubtless owing to our armour plate being thicker, giving an increased weight of between 300 and 400 tons.

THE "BAROSSA" was again taken to the measured mile off Maplin Sands on the 20th ult. for a further trial of her machinery, after having had the internal arrangement of her steam-pipes altered. The result of the trial was very satisfactory, considering the heavy gale which was blowing at the time, the force of wind being from 7 to 8. The results attained were:—Average speed per hour, 10 knots; revolutions, 59; pressure of steam, 18lbs.; vacuum, 24lbs.

THE FRENCH FRIGATE "MAGICIENNE."—The power of traction possessed by this new steam frigate has been proved by the dynamometer at Toulon to be equal to 24,400 kilogrammes, which is considered as highly satisfactory. The captain of the *Magicienne* has received orders to take on board a full complement of coal, and try her speed in a trip to the islands of the Hyeres. She is then to proceed to Algiers to make a decisive trial. The shipwrights at Toulon say this frigate is the most perfect model of a vessel of war yet constructed. When fitted with the new apparatus for producing a more abundant supply of steam, it is expected she will be the fastest steamer afloat.

STEAM SHIPPING.

CUNNINGHAM'S SCREW PROPELLER PROTECTOR.—On the 5th ult. an experimental trial was made at Spithead of an invention by Mr. H. D. P. Cunningham, R.N., for protecting the screw-propeller of men-of-war steamers from being fouled by floating wreckage or gear of any kind, liable to be drawn by the current towards the screw. The trial was made under the direction of Commander Miller, of her Majesty's ship *Asia*, and other officials. The screw and protector invented by Mr. Cunningham were fitted to a small schooner-yacht, the property of the inventor. The yacht was towed astern of the *Swinger* gunboat, the screw of the schooner being kept working. A quantity of loose spars, ropes, and other gear was then thrown overboard from the *Swinger* and the yacht, so managed as to place the screw and apparatus under every possible disadvantage, with the view of fully testing the system. Every endeavour, however, to foul the screw with loose gear failed. The apparatus is most simple, consisting of iron bars projecting from the stern-post and netting, the whole of which, when not in use, lies close to the ship's quarter. The screw protector will form a valuable auxiliary to the screw under circumstances of difficulty, as regards wreckage and floating masses likely to disable the propeller.

MR. LUMLEY'S PATENT DOUBLE RUDDER was tested at Portsmouth against the ordinary form of rudder, on the 6th and 7th ult., in the *Bullfinch* gunboat, and is understood to have proved a great success, it having developed a power of steering a vessel under steam considerably beyond that possessed by the ordinary rudder, and at a much less expenditure of motive power. The method selected to test the principle was by making circles, as is done with Her Majesty's ships when under trial at the conclusion of their measured mile runs in Stokes Bay. The rudder of the *Bullfinch* had been cut in two and fitted on Mr. Lumley's plan, and with this the trials commenced on the 6th ult., and were attended with the following results, the experiments being carried out near the Warner light vessel, outside Spithead:—The gunboat was first put at full speed, when four circles were completed, two with the rudder at an angle of 30 deg., and the remaining two at an angle of 15 deg. In the first the circles were made respectively in 2 min. 12 sec., and 2 min. 26 sec. With the angles at 15 deg. the circles were made in 2 min. 31 sec., and 2 min. 53 sec. The boat was next started from being stopped dead, and the rudder at an angle of 35 deg. and the circle made in 2 min. 46 sec. The closing trials were at half speed, the first with the rudder at an angle of 39 deg. with which the circle was made in 2 min. 43 sec. In the last trial, at the same angle, the circle was completed in 2 min. 49 sec. The gunboat then returned to the harbour and was placed on the gridiron of the dockyard, when the rudder was restored to its normal condition, to obtain a comparative result by the trial of the 7th ult. This trial was made with the old rudder, and the result gave a loss of time in each instance as compared with Mr. Lumley's rudder. The result of the whole series is highly favourable to Mr. Lumley's plan.

THE AMERIGO VESPUCCO AND ALESSANDRO VOLTA, built for the Italian mail and passage service have both made their trial trips with the greatest success. They ran the distance between the Cloch and Cumbræ lights, at an average speed of 13¾ knots, being 1¼ knots in excess of their guaranteed speed. These vessels were built by Messrs. MacNab, and Co., Greenock, who also furnished their engines.

THE "ETNA," a finely modelled screw steamer of 450 tons, was launched from the yard of Messrs. Scott and Co., Cartsdyke, on the 14th ult. She is the property of Messrs. Florio, of Palermo, and is a sister vessel to the *Campidoglio*, launched by the same firm in August. Her engines, of 150 horse-power, will be supplied by the Greenock Foundry Company, and she will be employed in trading between Sicily and the Italian Coast.

THE "TAMAR," Royal Mail Company's steamship, which had just completed a thorough refit and overhaul, went out for an official trial trip at Stokes Bay, on the 10th ult. previous to her return to Intercolonial service in the West Indies. The *Tamar* ran the measured mile four times with the following results:—1st run, 5 min. 17 sec., equal to 11·353 knots per hour; 2nd run, 4 min. 32 sec., 13·235 knots; 3rd run, 5 min. 25 sec., 11·009 knots; 4th run, 4 min. 24 sec., 13·636 knots. Mean of the four runs, 12·309, Draught forward, 14ft. 5in.; aft, 15ft. 3in.; 340 tons of coal and 11 tons of water on board; revolutions of engines, 17½ to 18½, steam, 17; wind fresh from S.W.

THE SCREW STEAMER "TYNEMOUTH" arrived at San Francisco, California, on the 10th September, exactly three months after her departure from England. The *Tynemouth* was 92 days in all on the passage, but deducting the stay at Stanley Harbour, the time under weigh was only 79 days. The *Tynemouth* is an iron-built screw ship, of 1228 tons register, and 1364 tons gross register, including her engine rooms. The owners have despatched her, by way of experiment, to ascertain whether a class of vessels of this description will pay to take up the line from London to California and British Columbia. She took on board 900 tons of north country coal, of which there remained on board on arrival at Stanley Harbour, on the 23rd July, or the 43rd day from Dartmouth, 412 tons, so that her consumption was 488 tons to drive the ship 7373 miles. The greatest distance run was 252 miles in 24 hours, under full sail, and the engines disconnected. This was exactly 10½ miles per hour, with a fair wind right aft. The number of hours under steam to Stanley Harbour was 1009, and the average consumption of coal was 9·6729 cwt. per hour.

LAUNCHES OF STEAMERS.

LAUNCH OF THE "CALEDONIA."—The armour-plated screw frigate *Caledonia*, of 34 guns and 1000 horse-power, was launched in a most successful manner from No. 1 slip, at Woolwich Dockyard, on the 24th ult., under the direction of Mr. Turner, master shipwright. The *Caledonia* was laid down about three years since as a 90-gun timber frigate, but the Admiralty having abandoned the building of such vessels, she was altered and re-constructed as an armour-plated ship under the direction of Mr. Turner, master shipwright, who introduced several improvements in the construction of her frame, which is more than usually solid and substantial, and fully capable of sustaining the immense weight of iron which will be on her sides. The contractor for the supply of her four-and-a-half inch wrought-iron plates is Mr. Brown, of Sheffield; and the most complete machinery, consisting of hydraulic presses, planing and drilling machines, &c., has been fitted up in a shed erected close to the dock where the vessel remains. About 200 workmen will be employed for her completion, and when ready for service she will receive an armament of the muzzle-loading rifled guns recently adopted by the Admiralty for the Royal Navy. The following are her principal dimensions:—Length between the perpendiculars, 273ft.; length of keel for tonnage, 231ft. 3¾in.; extreme breadth, 59ft. 2in.; breadth for tonnage, 57ft. 11in.; breadth moulded, 57ft. 1in.; depth in hold, 19ft. 11½in.; burden in tons, builders' measurement, 4125 39/94.

MILITARY ENGINEERING

THE ARMSTRONG GUN.—A notification has been received at Chatham that the 9-pounder Armstrong gun, recently approved for the Horse Brigade, Royal Artillery, has been adopted for naval service. The 9-pounder Armstrong will, therefore, be in future substituted for the 12-pounder gun at present used in the armament of pinnaces and barges from 28ft. to 32ft. in length. It will also be used for field marine service, and will be supplied to every vessel placed in commission. A 200-pounder muzzle-loading gun, manufactured by the firm of Sir William Armstrong and Co., at Elswick, has been received at Woolwich Arsenal, weighing about eight tons, and was forwarded to the proof-butt to be tested for service. The Armstrong guns tested at Woolwich lately have met with some serious reverses by the bursting of no less than three of the 100-pounders during proof at the butt on the 2nd ult. and the preceding day. On the 9th ult. two of these huge guns, loaded with an over-proof charge of 27½lb. of powder, and a 110lb. solid shot, burst through the B coil, immediately behind the trunnions. The coil and the internal tube were severed, and the portion of the tube remaining in the breech piece was also rent and torn in several places longitudinally by the concussion. The third gun was separated in the centre of the barrel or chase, and gave way transversely, almost as though cut through with a saw. Each of the guns had been fired for some days past experimentally to test the vent pieces, and one had fired over 200 rounds.

IMPROVEMENTS IN GUNPOWDER.—Some improvements in the mechanism required for, and in the manufacture and composition of, gunpowder have been invented by Mr. Wm. Bennetts, of Tuckingmill, Camborne. The ingredients consist of lime, nitre, sulphur, and charcoal. The lime is dissolved in a sufficient quantity of water to bring the other ingredients into a paste. The lime, after having been made into a solution, is strained through a fine sieve; this solution is added to the other ingredients. The whole is then put into a mill, and ground until it becomes a paste. It is then taken out of the mill and passed between two rollers; one roller is grooved, the other is plain. The powder by passing between the rollers is formed into long strips of a triangular shape. It is then carried on an endless web or canvas over some hot tubes, which are heated by steam, hot water, or any other artificial heat which may be applied. By this means the powder is easily broken into grains. This mode of manufacture prevents a great deal of danger, as the powder is pulverised and brought into grains while in a wet state. The lime makes a firm grain, and resists the damp, and gives a certain degree of lightness, which increases the bulk 25 per cent. over ordinary gunpowder, which is a great advantage for blasting purposes. Plaster of Paris, blue lias, Roman or Portland cement, or other strong cementing substance may be used as a substitute for lime. And he finds that for blasting purposes the following proportions answer very well—nitre, 65 parts; charcoal, 18; sulphur, 10; and lime, 7; but the proportions vary according to the strength required.

SUBMARINE GUN.—Mr. H. Redsull, of Deal, has invented a submarine gun and port, a plan of which has been submitted to the Lords of the Admiralty. The chief feature of the invention is to allow the barrel of a gun to be forced through the ports in order that a shot may be discharged from it to pierce vessels below the water-line and iron-coating when in close action, without taking water in the ports. It is calculated that a vessel fitted with this invention will be able to sink the *Warrior* in a few seconds. The expense of fitting vessels will be very moderate, as it is contrived that almost any piece of ordnance may be used at the submarine port.

TELEGRAPHIC COMMUNICATION WITH CHINA.—An important order of the day of the Director-General of Ways and Public Works states that the construction of the line of Siberian telegraph, which has already reached Omsk, and will, in the course of the next year, be extended to Irkutsk, has, with the assistance of the post, allowed of a more rapid interchange of communication between Europe and China, and arrangements have been carried out to enable the Western Powers to correspond with China, *viâ* Russia. Despatches from the interior of the empire, destined for Kiachta and Pekin, will be received for transmission at the telegraph stations at St. Petersburgh, Moscow, and Nijni-Novgorod.

TELEGRAPHIC ENGINEERING.

THE PACIFIC TELEGRAPH COMPANY have erected their wires between the Missouri and the Sierra Nevada, a distance of 1600 miles, and thus completed the telegraphic communication between the Atlantic and Pacific in four months and seventeen days. The company have entered into an arrangement with the Emperor of Russia, by which, conjointly, they will construct a continuous line through British and Russian America, across Behring Straits, and through Asiatic and European Russia, so as to connect St. Petersburgh and Washington. This line will be 14,000 miles in length. Russia has already completed 3500 miles, and collected materials for extending the wires from Siberia to the mouth of the Amoor, the Mississippi of Asiatic Russia.

RAILWAYS.

WORKING EXPENSES OF RAILWAYS.—The whole sum paid as working expenses on railways in the United Kingdom amounted last year to £13,843,337, as compared with £13,187,368 in 1860. The receipts were £28,534,635 last year, as compared with £27,748,486 in 1860; and the proportion of working expenses to revenue rose consequently to 48 per cent. last year, as compared with 47 per cent. in 1860, the net receipts having only advanced from £14,561,118. in 1860 to £14,691,296 in 1861. The proportion of working expenses to revenue was in England and Wales last year 49 per cent., as compared with 48 per cent. in 1860; in Scotland, 45 per cent., as compared with 44 per cent. in 1860; and in Ireland, 44 per cent., as compared with 45 per cent. in 1860. Thus while the railway management of England, Wales, and Scotland appears to have retrograded, that of Ireland has improved. Taking the United Kingdom generally, the charge for maintenance of way amounted last year to 18·37 per cent. of the whole working expenses, as compared with 18·48 per cent. in 1860; the charge for locomotive power was 28·44 per cent. of the whole working expenses last year, as compared with 28·83 per cent. in 1860; the charge for repairs and renewals of plant was last year 8·94 per cent. of the whole working expenses, as compared with 8·46 per cent. in 1860; the traffic charges (coaching and merchandise) were 27·94 per cent. of the whole working expenses last year, as compared with 28·05 per cent. in 1860; the charge for rates and taxes was 3·94 per cent. of the whole working expenses last year, as compared with 3·93 per cent. in 1860; the charge for Government duty was 2·62 per cent. of the whole working expenses last year, as compared with 2·75 per cent. in 1860; the charge for compensation for injuries to passengers was 0·98 per cent. of the whole working expenses last year, as compared with 1·37 per cent. in 1860; the charge for compensation for damage and loss of goods was 0·44 per cent. of the whole working expenses last year (in 1860 no similar analysis appears to have been instituted); the legal and Parliamentary expenses were 1·58 per cent. of the whole working expenses last year (in 1860 no similar analysis appears to have been instituted); and the miscellaneous charges not otherwise particularised were 6·75 per cent. of the working expenses last year, as compared with 8·10 per cent. in 1860.

TURIN AND SAVONA RAILWAY.—The first annual meeting of this Company was held in Turin on the 1st ult. The engineer-in-chief reported that that the works were being conducted with energy and to his satisfaction, the heavy works—namely, the tunnels, the keys to the completion of the line—being prosecuted night and day. The proceedings were harmonious, and the Shareholders occurred in the views entertained by the Directors of the Company, who were re-elected wthout a dissentient voice.

HULL AND HORNSEA.—The ceremony of turning the first sod of this railway was performed on the 8th ult., by Mr. J. A. Wade, the chairman of the Company, at Hornsea. The new line will form a junction with the North Eastern Railway Company's Victoria-dock branch, near Hull, over which the trains will run for about three miles. The length of the Hornsea line will be about 13 miles, but, including the portion run over the North Eastern, the total mileage will be over 15. The line is to be laid upon the most approved method, and it is expected that it will not cost more than £60,000. Messrs. S. und T. Crawshaw are the contractors, the contract being taken within £200 of the engineer's estimate, and is to be completed and in work by the commencement of next year's season in July. It is expected, from the importance of the district through which the line will pass, the easy gradients and works, and the light capital cost, that it will prove one of the most remunerative railways undertakings in Yorkshire.

BERWICKSHIRE.—The ceremony of cutting the first turf of this railway took place at Greenlaw on the 14th ult. The formation of this new line has been looked forward to with great interest. The Berwickshire Railway will form a connecting link between the two great trunk lines of the North British system. It will be 20½ miles long; including the Dunse branch, which is 8¾ miles long, the extent of the connecting line between the east coast and the Waverly route will be 29½ miles. It commences at Dunse, which is connected with the eastern line of the North British Railway by a short branch line to Reston Junction. From Dunse it runs in a south-westerly direction, by way of Greenlaw and Earlston, to near Newstead, a mineral station on the Waverley route, between Melrose and Newtown Junction. The Tweed will be crossed by a viaduct of ten or twelve arches, at a height of 130 feet, and the arches will embrace not only the river, but the public roads on either side.

THE GREAT NORTHERN RAILWAY COMPANY are lighting their carriages with portable gas, instead of oil lamps. A difficulty, however, remains to be overcome. The sudden rush of air, on entering a tunnel, is apt to put out the gas light.

GREAT INDIAN PENINSULAR RAILWAY.—The report of the directors for the half-year state that the gross earnings in respect of the 437¼ miles open for traffic, amounted to £239,688. Of this sum £72,542 was deducted to meet the cost of conveying by the ordinary means the traffic across the gaps in the railways at the Bhore and Thull Ghâts, and at the Goolburn Ravine. The working expenses amounted to £103,715, or 62·10 per cent., leaving £63,431 as net profit, to be carried to the credit of the company's interest with the Government. The cost of maintaining the line and works was 8*d*. per train mile. The works on the Bhore Ghât incline were in so forward a state that it was expected they would be completed by the end of March next. The capital account showed that £9,654,040 had been received, and £8,521,934 expended, leaving a balance of £1,132,106.

RAILWAY ACCIDENTS.

ACCIDENT ON THE GREAT NORTHERN RAILWAY.—A singular accident occurred on the Great Northern Railway, a few miles south of Huntingdon, on the 1st ult. It appears that, before the break of day, a luggage train passed down the line from London to York. On one of the trucks was the steam engine belonging to a thrashing machine. From some cause the fly wheel of this engine slipped off unperceived when the train was passing the Offord station, and fell across the up line of rails. Shortly afterwards, and whilst it was still dark, a mineral train came up and dashed with violence against the fly wheel, which, being of considerable weight, formed a serious obstruction. The consequence was that the engine and tender were thrown off the rails, both driver and stoker being killed on the spot. Many of the waggons were much shattered, their contents being strewn over the line for some distance. The platform of Offord station was also damaged for a length of about 20 yards.

ACCIDENT ON THE NORTH-EASTERN RAILWAY.—A collision occurred on the North Eastern railway on the 3rd ult., which caused a sacrifice of life, although not to so fearful an extent as is generally the case in accidents of a similar kind. Fortunately, the collision took place between two goods trains, otherwise the extent of the consequences must have been very serious. The one train was travelling on the up line; the other was moving across the track of the first, in leaving a siding to get on the down line. As the former was going at full speed, between twenty and thirty miles an hour, the crash was very great. The fireman of one of the engines was cut to pieces. The rest of the men in charge of the respective trains were only slightly hurt. The occurrence happened two miles north of Milford Junction.

COLLISION ON THE SOUTH WESTERN RAILWAY.—On the 10th ult. an accident occurred near the Guildford Station, attended with no loss of life, but with great loss of property. It appears that about 20 minutes past eleven o'clock, as the goods train which leaves Alton at 9.35 was approaching the station, the engine-driver observed the danger signal set, and immediately shut off the steam, reversed the engine, and used every means in his power to slacken the speed; but as the train had just arrived at the incline, which is at this place 1 in 100, and which extends for about two miles and a quarter, his efforts were of little avail, and the train went rushing on. The guard also applied the breaks, but a heavy storm which had just fallen rendered their application almost useless; the consequence was that the train went at a rapid pace down the incline, at the foot of which it came into collision with the "pick-up" goods train of the South Eastern Railway, consisting of about 30 waggons, which was performing its ordinary shunting at the time. The engine-driver of the South Eastern Company's train, hearing the whistle of the approaching train, and being fully aware of the inevitable danger, with great self-possession immediately ran a head, taking with him about half the train, which had been previously detached, and thus no doubt prevented a double collision. Of the remaining waggons belonging to the South Eastern Company, seven were completely smashed and rendered unfit for use, including the guard's break-van, which was empty. Of the South Western train, which contained about thirty waggons, four were overturned and greatly damaged, whilst several others were shattered to pieces, the massive iron work being bent and broken like so many straws. The tender, which, being before the engine, struck the guard's break, was much damaged, the water tank being completely driven out of its frame. The wheels of several waggons were broken off, and as an illustration of the force of the collision, the trucks themselves were piled up one upon another nearly to the height of the railway bridge.

ACCIDENT ON THE LONDON, CHATHAM, AND DOVER RAILWAY.—The mail train leaving Victoria Station at eight p.m., met with an accident on the night of the 13th ult., between Sittingbourne and Teynham stations, and close to the latter. The train in question passed through Sittingbourne at 29 minutes past 9 p.m., and on reaching a place about two miles from Sittingbourne, it ran off the line, tearing away part of the up-line, then apparently jumping back to its own line, and at last, with its tender, being thrown right across the line. The second-class carriage, next the tender, was completely detached from it, and thrown off to the outer side of the down line; the other carriages were partially upset. The engine-driver was thrown off, and was found dead, with the fire-box of the engine resting on his breast. The stoker escaped with a few slight bruises. Six of the passengers received slight contusions. The line presented a most extraordinary aspect. For a distance of nearly 100 yards both the down and up lines were torn away. The upper part of the engine was partially embedded in the earth, part of the funnel being thrown about ten yards in advance, and the "dome" being sent rolling nearly 20 yards on the opposite or down line.

ACCIDENT ON THE EDINBURGH AND GLASGOW RAILWAY.—On the night of the 13th ult., a most disastrous railway accident took place near Winchburgh, on the Edinburgh and Glasgow Railway, involving great loss of life and serious injury to a large number of passengers. The accident occurred to the passenger train leaving Edinburgh for the north at six o'clock in the evening, which came into collision with the ordinary passenger train which left Glasgow at five o'clock, at a short distance west of Winchburgh. It appears that for some time past repairs had been making on a portion of the line between Winchburgh and Linlithgow, and during the repairs the trains have been running there on a single line for a short distance. The train which left Edinburgh for Perth at six o'clock was a small train, consisting of two third-class and two first-class carriages, with one van and a horse-box. It reached Ratho, the first stopping station, all right about a quarter past six o'clock, and proceeded to Linlithgow, its next stopping station, where it was due at thirty-five minutes past six o'clock. Shortly after passing Winchburgh, about half-past six o'clock, and while it was on the single line of rails, the train came into collision with the passenger train from Glasgow, which was an unusually heavy one. The engines and tenders of both trains were smashed to pieces, and tilted up on their ends; the first carriage of the Scottish Central train from Edinburgh, a third-class, was completely destroyed, as was also a third-class carriage in front of the Glasgow train. Piled above the *débris* of these carriages and the engines and tender were a large number of the carriages of the Glasgow train, chiefly third-class, with their numerous passengers. The accident resulted in the loss of 16 killed, and nearly 100 persons more or less seriously injured.

BOILER EXPLOSIONS.

MANCHESTER ASSOCIATION FOR THE PREVENTION OF STEAM BOILER EXPLOSIONS.—At the monthly meeting of the Executive Committee of this Association, September 30th, 1862, the chief engineer presented his monthly report, of which the following is an abstract:—"I am able again to report that no explosion has happened during the past month to any boiler under the inspection of this Association, neither has the occurrence of any in other quarters come to my knowledge. During the past month there have been examined 263 engines and 451 boilers. Of the latter, 15 have been examined specially, 6 internally, 72 thoroughly, and 358 externally; in addition to which 4 of these boilers have been tested by hydraulic pressure. The following defects have been found in the boilers examined:—Fracture, 8 (1 dangerous); corrosion, 49 (8 dangerous); safety-valves out of order, 3; water gauges ditto, 14; pressure gauges ditto, 4; feed apparatus ditto, 3; blow-off cocks ditto, 16 (1 dangerous); fusible plugs ditto, 5; deficiency of water, 1; blistered plates, 3 (1 dangerous);—total, 106 (11 dangerous). Boilers without glass water gauges, 5; without pressure gauges, 1; without blow-off cocks, 17; without back pressure valves, 25. Two boilers have recently been met with, neither of which was fitted with its own separate safety-valve, but both were dependent on a single one placed upon the steam pipe, the communication between which and each boiler was conditional on its junction valve being open, so that had the attendant at any time inadvertently left this valve screwed down—on getting up steam, for instance, on a change of boilers—the whole steam pressure must have been bottled up without chance of escape. Some of our members do not appear to be fully aware of the importance of fixing a feed back-pressure valve to each of their boilers, and therefore the following instance, lately met with, of the inconvenience arising from the want of them, may be given. Four boilers, set side by side and connected together, were working under their ordinary circumstances, when one of them vomited its water through the feed pipe into the adjoining one, draining itself and over-charging the other. The danger of this, if not immediately detected, with a fire in active operation, will at once be seen. It is, however, by no means an uncommon occurrence where back-pressure valves are omitted, especially where any thickening matter exists in the water, which tends to lift it and cause priming, under which circumstances the water has been found to rush backwards and forwards alternately between boilers working in connection. The back-pressure valve prevents this; the water from the feed pump operating underneath and raising it, while the pressure from the boiler operates on the top and closes it. Necessary as these valves are to the safety of boilers when working in a series, they should not be neglected in the case of those working singly, not only when fed by a pump, but also when fed direct from the waterworks main; in the first case, in order that the pump-valves may be accessible when steam is up; and in the second, that the reflux of hot water from the boiler may be prevented either on the bursting of the pipe or other cause. These valves should be placed immediately upon the shell of the boiler, and not at a distance from it, as is sometimes the case, since scalding might ensue should any joints break in the intervening length of pipe, while repair could not be effected without letting the pressure down. For the same reason the feed-stop valve should not be interposed, which it too frequently is, between the back-pressure valve and the boiler, since a disarrangement of the stop valve may entail an entire stoppage, which, had the feed back-pressure valve been placed immediately upon the shell, could easily be rectified with steam up. In the construction of this valve care should be taken to limit its rise, for want of which simple precaution some of them have proved to be entirely useless, the water passing freely from one boiler to the other as if the valve were not there. Its most convenient position is at the front end plate of the boiler, nearly on a level with the furnace crown. Its beat can then be heard at every stroke of the engine, and if a screwed spindle be added, so as to convert it into a combined feed-stop and back-pressure valve, which is the best arrangement, then the feed can be regulated without leaving the furnaces. A case of scalding has lately occurred in consequence of the failure of the blow-out apparatus of a boiler which was, however, not under the inspection of the Association. The manner in which blow-out taps are often strained with long levers in opening and closing renders it a matter of surprise that fracture does not more frequently occur, and many have such inefficient arrangements for carrying off the waste water that it beats back with so much violence, on the taps being opened, that their use is quite dangerous. Enginemen are in this way but too frequently scalded severely, and our own inspectors sometimes meet with narrow escapes. Some taps are so inconveniently placed that the nut at the bottom of the plug is quite inaccessible, and thus becomes neglected, in consequence of which several cases have occurred of the plug being shot out by the force of the steam on being opened. Taps fitted with glands are safer as well as more convenient; they should, however, be made entirely of brass in the shell as well as in the plug, and be fitted with a suitable waste pipe. Those made of cast iron in the shell and brass in the plug are generally found to be inconvenient and sometimes dangerous, on account of the unequal expansion of the two metals, from which it is frequently impossible to close them, when the boiler becomes robbed of its water, and the fires have to be drawn to prevent injury to the furnaces. The case in question, however, was somewhat peculiar, and the fracture did not arise from either of the above causes. The blow-out tap was attached to the boiler by a cast iron elbow pipe, and this pipe broke short off without warning, while the boiler was at its regular work, and the blow-out tap not being touched. The cause of this appeared to be as follows:—Boilers, as it has been previously stated in these reports, are too frequently considered to be in a state of rest when once set upon their brickwork bed; whereas, from the constant changes of temperature, and the consequent contraction and expansion that take place, not only in the boiler itself, but also in the brickwork, the whole is in a continual state of movement. It appears most probable that this action had in process of time induced a slight settlement of the boiler, and thus that a strain was brought upon the cast iron elbow pipe, which, being bound by the brickwork, consequently gave way. A torrent of hot water naturally ensued, which, unable to escape at the usual outlet, found its way into an adjoining building, where it partially flooded one of the floors, and two or three persons became scalded in consequence. It may be stated in brief that the scum pipes for surface blowing out, which have been recommended from time to time for the prevention of incrustation in boilers, have now been adopted by several of the members, and have for some time since been in very successful operation. An early opportunity will shortly be taken of making more detailed reference to this subject, but in the mean time it may be stated that a drawing of the arrangement adopted lies at the office for the inspection of the members, and that full particulars, both of the details of construction and results of working, will be given on application."

DOCKS, HARBOURS, &c.

THE CLYDE.—The accounts of the River Clyde Trustees for the financial year 1861-2 have appeared, and are of high interest and importance. The income for the year was £111,493, being an increase of £5724 as compared with the revenue of the preceding twelve months. The ordinary annual expenditure, including dredging for the maintenance of the depth of the river, amounted for the past year to £32,764, the interest on the bonded debt to £50,524, and the ground annuals and feu duties to £4435, making a total of £87,724, and leaving a surplus of £23,768. The trustees are still engaged in deepening and improving the river, and the expenditure on this head amounted to £63,700 during the past year; but, deducting the balance carried to capital account from revenue, the actual increase of the bonded debt during the year was £44,755. The bonded debt due by the trust amounts in round figures to £1,244,000, the borrowing powers granted by Parliament being altogether £1,504,000. The goods imported into the Clyde last year amounted to 1,380,218 tons, being an increase of 13,891 tons as compared with 1860-1, and the register tonnage of vessels arriving in the harbour was 1,530,642 tons in 1861-2, and 1,504,220 tons in 1860-1. The expenditure on dredging account is expected to be reduced in future by the employment of screw steam barges, which will receive the stuff dredged up and deposit it at sea, instead of its being laid, as hitherto, on some portion of the banks of the river. From 1770 to 1862 the total sum expended in the improvement of the Clyde was £3,407,714, the principal items being the following:—General management and officers' salaries, £141,398; general expenditure, repairs, and maintenance of works, £146,942; extraordinary repairs, Parliamentary opposition, &c., £50,614; ferries, wages, and repairs of boats, £22,511; ground annuals and feu duties, £80,371; law and Parliamentary expenses, £28,324; police, £62,456; interest on loans, £754,698; dredging in river and harbour, £323,810; repairs of machines, punts, tug-boats, &c., £209,509; land purchased for the enlargement of the harbour, £437,779; land purchased for widening the river, £154,154; acts of parliament, £45,401; construction of works in the harbour, £544,203; ditto in connexion with the river, £324,634; engineering and surveying, £17,710. The aggregate revenue acquired in the same period was £2,170,363, the deficit being raised by loans incurred on capital account. The revenue has made steady progress year by year. Thus in 1770 it amounted to £147; in 1780, to £1515; in 1790, to £2239; in 1800, to £3319; in 1810, to £8676; in 1820, to £6328; in 1830, to £20,296; in 1840, to £46,536; in 1850, to £64,243; in 1860, to £97,983; while in 1861-2 a total of £111,493 was attained, as previously indicated. It will not escape attention that the progress made has been much more rapid of late years than in the earlier history of the trust.

HARBOURS OF REFUGE.—Our attention has been drawn to a breakwater, invented by Mr. W. Bennett Hays, engineer. One of them was executed some few years ago for the Government of South Australia, but, from unexpected difficulties, arising from the rocky nature of the soil, it has not yet been erected. It will be constructed in bays of 20ft., supported on cast-iron screw piles, the platforms being ⅝in. boiler plate, put together with ⊥ irons on the upper side, riveted on in a transverse direction, and Barlow's rail, inverted, and riveted longitudinally as bearers on the under side, and further stiffened by pipes and bolts connecting the plates together in the middle of their length. The plates will be carried upon frames of bar-iron, 6in. by ⅞in., riveted together with cross and diagonal pieces, each plate having a 3½in. angle-iron on its end by which it will be bolted to the frames, and be supported by small cast-iron brackets, also bolted to the frames. The frames themselves, when in their places, will be bolted to one another, and will rest upon step castings attached to the piles, and be connected to the piles by wrought-iron clips and links. The breakwater will be arranged in the form of a crescent, presented towards the point of the prevailing winds, and is 240ft. in length.

SEWERAGE WORKS.

THE METROPOLITAN BOARD OF WORKS have just published their annual report, which is chiefly occupied with the progress of the main drainage. The northern high-level sewer is completed and working. The mid-level is about half completed. The low-level was kept back till the question of the Thames embankment was decided; it will now be proceeded with as a part of that scheme, and the Strand and Fleet-street will be avoided. The works on the south side are not in such a forward state. A remarkable feature in the report is the accuracy of the estimated expenditure made by the engineer, as proved by the price for which the contractors have engaged to construct the works. The difference is slight in every case, but generally it is in favour of the public.

ACCIDENTS TO MINES, MACHINERY, &c.

DEATH FROM THE FALL OF A TELEGRAPH.—On the 23rd ult. a telegraph wire, crossing the Thames at Blackfriars Bridge, which had been broken by the gales then prevailing, became entangled around the neck of a man seated outside an omnibus. The man was hurled into the road, and shortly afterwards expired.

COLLIERY ACCIDENTS.—The reports of the Government Inspectors of Mines have just been made up, and show that mining accidents unfortunately increased last year, as compared with 1860. The number of fatal accidents from explosions of firedamp was 61 in 1861, and 70 in 1860; from falls of coal and ironstone, 156 in 1861, and 140 in 1860; from falls of roof, 257 in 1861, and 239 in 1860; from overwinding, 6 in 1861, and 4 in 1860; from ropes and chains breaking, 7 in 1861, and 12 in 1860; from casualties occurring while ascending or descending shafts, 40 in 1861, and 34 in 1860; from matters falling into shafts from the surface, 5 in 1861, and 6 in 1860; from matters falling from part of the way down shafts, 22 in 1861, and 32 in 1860; from miscellaneous casualties in shafts, 19 in 1861, and 21 in 1860; from explosions of gunpowder, 14 in 1861, and 9 in 1860; from suffocation by gases, 10 in 1861, and 7 in 1860; from irruptions of water, 4 in 1861, and 2 in 1860; from falling into water, 0 in 1861, and 4 in 1860; from casualties by trains, inclined planes, &c., 72 in 1861, and 79 in 1860; from underground machinery, 4 in 1861, and 5 in 1860; from miscellaneous casualties underground, 19 in 1861, and 10 in 1860; from surface machinery, 22 in 1861, and 23 in 1860; from boilers bursting, 2 in 1861, and 3 in 1860; from miscellaneous surface casualties, 42 in 1861, and 22 in 1860; making a gross total of 811 in 1861, and 769 in 1860. Dividing the accidents into five great classes, the following more general results may be arrived at:—Accidents from explosions of firedamp, 61 in 1861, and 70 in 1860; accidents from falls in mines, 413 in 1861, and 379 in 1860; accidents in shafts, 148 in 1861, and 157 in 1860; accidents underground, 123 in 1861, and 115 in 1860; accidents on surface, 66 in 1861, and 48 in 1860. The proportions in which the 811 fatal mining accidents of last year occurred were as follows in the various districts into which the kingdom is divided for purposes of official inspection:—Northumberland, Cumberland, and North Durham, 95; South Durham, 75; North and East Lancashire, 67; West Lancashire and North Wales, 78; Yorkshire, 65; Derbyshire, Nottinghamshire, Leicestershire, and Warwickshire, 43; North Staffordshire, Cheshire, and Shropshire, 41; South Staffordshire and Worcestershire, 115; Monmouthshire, Gloucestershire, Somersetshire, and Devonshire, 66; South Wales, 91; East of Scotland, 39; West of Scotland, 36. These details refer, it will be seen, to both coal and ironstone mines. With regard to coal mining more particularly, it appears that in the five years ending Dec. 31, 1860, 380,467,047 tons of coal were raised in Great Britain, and that 5095 lives were sacrificed in obtaining them. Thus every 74,674 tons of coal made available for consumption cost a human life!

GAS SUPPLY.

GAS IN GERMANY.—The following data, relating to the use of gas in Germany, have been derived from the reports of the meeting of the gas companies at Berlin. Gas is now used in 296 towns, numbering a total of 5,750,000 inhabitants, and consuming 3,600,000,000 cubic feet of gas. The number of jets amounts to 1,810,000,000, of which 750,000 are required for street lamps. The coal consumed in the manufacture exceeds 7½ millions cwt., and the pipes in the main road, exclusive of the branches laid on to houses, are 3600 miles in length. A capital of 33,000,000 thalers is at the disposal of German companies alone, the English companies competing with them in many of the largest towns not being included in the estimate. Nearly one half of the coal used comes from England, a considerable part of Northern Germany, Berlin included, finding it cheaper to pay for sea freight than for land carriage from the mines at home. Of German coals, the Westphalian beds alone furnish 1,300,000 cwt.; the Saarbrück coal, which is the best on the continent, and quite equal to the finest Newcastle, coming in for a consumption of 500,000 cwt. only, owing to the distance of the coal-fields from the great towns of the confederacy. This coal is, however, largely exported to France. From a similar reason, the Silesian fields, many of which yield an excellent coal, and in such profusion as to suffice for the wants of the entire continent for hundreds of years to come, cannot be made available for gas manufacture beyond the small item of 350,000 cwt. a year. The Zwickan and Planen coals are conveyed to the gasworks of Leipsic, Dresden, and other manufacturing towns of Saxony, to an amount of 655,000 cwt. per anunm. Besides the gas-works using coal, there are twenty others making their gas out of wood. Turf is employed by two, and one company has recourse to boghead. The increase of gas-works in Germany coincides with the rapid development of the nation in every branch of commerce and industry during the last twelve years; for while, in the beginning of 1850, there were only twenty-four in existence, every succeeding year added considerably to the number. In the course of 1850 three more were opened at Cassel, Freiburg, and Munich; in 1851 three others appeared upon the field; in 1852 there were seven more; in 1853, five; in 1854, eleven; in 1855, thirteen; in 1856, twenty-seven; in 1857, thirty-seven; in 1858, thirty; in 1859—the year of the Italian campaign—nineteen; in 1860, thirteen; in 1861, thirty; in 1862, thirty-five. A number equal to the last is expected for the next year. Of the 266 existing gas-works, 66 belong to municipal corporations or the Government, and 200 are the property of private companies.

The Eton Gas Company have declared a dividend at the rate of 7½ per cent. per annum, which has been the average of profits since the establishment of the company. The Sheffield Gas Company recommend the usual dividend of 10 and 8 per cent. placing a surplus to their reserve fund. The gas company at Newport, near Montrose, who lately reduced their price of gas from 12s. 6d. to 10s. per 1000ft., find they still can pay the usual dividend of 5 per cent., and are able to set aside £28 odd to account of wear and tear, and the reserve fund is at the highest limit allowed by the Company's contract. The Surrey Gas Consumers' Company have declared a dividend of 8 per cent. per annum.

Copper Gas Pipes.—It has been discovered that when gas pipes constructed of copper or bronze have been long submitted to the action of ordinary coal gas, an explosive compound of copper and acetylen (one of the many ingredients of coal gas) is formed. When dry, this compound detonates with extraordinary violence as soon as it is rubbed, struck, or heated. Already many accidents have occurred, and some men have lost their lives, while cleaning large copper gas pipes, from this circumstance. No such explosive compound appears to be formed when iron or lead are used. It is evident that large copper gas pipes are unsafe, and some other metal should be substituted for copper, as the latter may give rise to explosions at any moment. As concerns small pipes constructed of this metal, they should not be allowed to get foul; and when about to be cleaned, hydrochloric acid should be introduced into them for about ten minutes before they are submitted to any heat or friction. Hydrochloric acid decomposes the explosive compound, combines with the copper, and puts the gas acetylen in liberty. The acid may then be washed out with hot water.

MINES, METALLURGY, &c.

Discovery of Iron, Copper, etc., in Ireland.—In the vicinity of Sixmilebridge, near Limerick, a deposit of valuable minerals, comprising iron, copper, lead, and sulphur, has been found, and from the account given of it there can be little doubt that it will attract the attention of capitalists. The iron is, perhaps, the most important deposit, it being a fine magnetic ore, similar in character to that of Sweden. The discoverer considers that it is the more valuable as it has never been found in England or Scotland. The sulphur is described as abundant, and of the finest quality, whilst it is so favourably situated that it could either be exported or manufactured on the spot with facility. The lead is also good, and the smelting and extraction of silver could readily be effected at the mines. The lead deposit extends over 2000 acres. The copper deposit extends over 4000 acres, and is also declared to be rich. The iron, copper, and sulphur could be worked by adit levels, and there is abundance of water to get power for working the lead. The properties are from one to six miles from a good harbour, free from dues or charges, and freights would be moderate. A sample of the iron ore has been analysed by Mr. Fred. Penny, of Glasgow, and found to contain—Protoxide of iron, 23·94; peroxide of iron, 67·33; lime, 1·23; magnesia, 0·58; phosphate, 1·20; silica, 3; carbonic acid, 2·72 = 100·00. Metallic iron, 65¾ per cent.

Copper Mining in the South of Spain.—Attention is now directed to a property which consists of 40 pertenencias of 60,000 superficial metres each, forming a district measuring in length about 13,000 metres from east to west, and about 3000 metres in width from north to south, contiguous to and running along the coast of the Mediterranean from Escombrera to Porman, the nearest pertenencia being about 1000 metres from the first-named place. From the numerous excavations made in different parts of the district, it appears that there exists in the whole of the property a continuous layer or seam of copper ore, about 2ft. in thickness. These seams are expected to increase in dimensions on a greater depth being reached, and to yield ore sufficient to work for an indefinite number of years. The assays made by several practical analysts of samples taken from various parts of the district have given results ranging from 8 to 40 per cent., the principal part of the seam giving from 14 to 18 per cent. of fine copper. The ore is composed of sulphurets, oxides, carbonates, and pyrites, in varying proportions. By the proximity of these mines to the sea shore, the expenses of shipment would be reduced to a minimum, whilst the excellent harbourage at Carthagena, as well as at Escombrera and Porman, would greatly facilitate its being shipped to England at moderate rates of freight.

Magnetic Electricity and Gold Amalgamation.—In amalgamating the gold of crushed quartz, it is said that a considerable quantity of the very finely subdivided particles are floated off without ever being brought into contact with the quicksilver. To make amalgamation with such fine gold dust practicable, magnetic electricity has lately been applied in San Francisco. The current of electricity is generated in a magneto-electro machine, driven by the steam engine which operates the crushers, and the current is sent through the mercury in the amalgamating trough. It is stated that the current of magnetic electricity increases the affinity of the mercury for the gold, and enables it to take up a larger quantity from the washings of the quartz.

APPLIED CHEMISTRY.

For Dyeing Wood Rose Colour by chemical precipitation M. Em. Monnier recommends the following method:—A bath A is prepared with 80 grammes of iodide of potassium per litre of water, and a bath B in another vessel with 25 grammes of bi-chloride of mercury. The wood to be dyed is first put in the bath A, when it is left for several hours; it is then dipped into the bath B, when it assumes a beautiful rose colour. The wood thus dyed is afterwards varnished; the baths will last a long time without any necessity for renewal.

Purity of Frozen Water.—M. Robinet has made a variety of experiments to ascertain how far water is freed from saline impurities by congelation; and his results go to show that the small amount of lime and magnesian salts in potable waters is forced out in the act of freezing as completely as the more soluble salts present in sea-water. Frozen water, he says, is so far purified that it may, in most cases, be used for chemical purposes in place of distilled water. In reference to this, M. Martens adds, that in his photographic excursions among the Alps he found that he could always use the water from the glaciers instead of distilled water, but that dissolved snow did not answer. Dr. Rudorff has also made experiments on the freezing of saline solutions. He employed the platino-cyanide of magnesium, the solution of which is colourless; but he found that when the solution was frozen so far that the water left was not enough to hold the salt dissolved, crystals of the well-known beautiful appearance were formed. Other curious results were observed with a supersaturated solution of sulphate of soda. When such a solution was cooled below the freezing point and the formation of ice prevented, it was found that a piece of ice dropped in determined the formation of ice, while a crystal of the salt caused the formation of crystals of the salt. A very small piece of the salt dropped in with ice caused the separation of the whole of the salt. He noticed, too, that the lowering of the temperature produced an alteration in the constitution of the solution. For instance when a solution of the blue salt, $Cu\,Cl + {}_{12}HO$, was frozen, the unfrozen water contained the green salt, $Cu\,Cl + {}_{4}HO$.

Crystals of Lead.—Stolba obtains lead crystals in a very simple way. He pours melted, but not overheated lead into a paper box—a pill-box would answer—and, as soon as the metal begins to solidify around the sides, pours away the metal which is still fluid. Experiments with tin, antimony, bismuth, cadmium, and zinc gave similar interesting results.

New Electrical Experiment.—M. Perrot, of Rouen, has made the following interesting experiment. In a glass vessel filled with oil, or other slightly conducting medium he mixes by agitation particles of gold-leaf, which thus remain in suspension. Into this bath he plunges, at a distance from each other, two ball-conductors, conducting the one with an electric-machine, the other with the ground. As soon as the machine is put in motion the currents are seen to form. The fragments of gold move towards the nearest sphere, and after touching it extend themselves towards the opposite ball. When these threads of metallic particles are carried out to a sufficient distance, the two currents meet, and are arrested, seemingly neutralizing each other, and escaping laterally to return towards their respective balls. If this experiment be made in oil or any other viscid liquid the particles of gold dispose themselves in lines as regular as those of ironfilings round a magnet. When the tension is feeble the lines formed by the gold particles going off from the two spheres unite in giving off a spark which illuminates the whole length of the metallic line. Sparks can be thus drawn out a hundred times the length of those got direct from the machine, and are obtained with scarcely any noise. M. Perrot thinks that in this we have an explanation of "heat lightning," as the silent summer flashes are commonly called, which, being produced without noise or tension, are thus to be distinguished from those producing thunder. The position of the neutral point between the two electric balls depends on the relationship of their respective surfaces. If the balls are equal, the point is midway; if a point is placed opposite to a ball, the neutral surface establishes itself very near to the latter. This mode of experimentation will probably throw light on some electrical phenomena hitherto very obscure.

Webster's Oxygen.—The gas is produced from materials of but trifling value, in large quantity, and by an operation requiring no skilled superintendence whatever. At first sight it would seem that the proportion of nitrogen present with the oxygen would tend to render the gas of only slight commercial value. A little consideration will, however, show that this is not necessarily the case. Although pure oxygen is invaluable in the laboratory, and at the lecture-table, its employment in an undiluted form would be impracticable in ordinary metallurgical operations on a large scale, as the intensity of its action would very soon rise to such a degree of violence as to reduce flux, fuel, metal, and furnace into one chaotic liquid mass. It is, indeed, very doubtful whether the mixed gas which is obtained in such abundance under this patent is not as strong as could be employed in most manufacturing operations without serious damage to the furnaces and crucibles used. The only case in which we believe a purer gas would be required is in the metallurgy of the more refractory platinum metals. The intensity of the "lime light" produced with this mixture is necessarily inferior to that obtained with pure oxygen, but it is abundantly sufficient for all ordinary purposes of illumination, and far better than we had anticipated from the composition of the gas. Indeed, it is only by comparing the two lights simultaneously, side by side, that the difference of intensity becomes apparent.

Preservative Action of Sulphate of Copper on Wood.—The experiments of M. Konig have demonstrated that the sulphate of copper deprives wood of the nitrogenous matter which acts as a ferment, this matter being found in the solution of copper. At the same time a combination of resin and copper is formed, which closes up the pores of the wood and preserves it from the action of the air. The wood, however, is still susceptible of decomposition, in consequence of the variations of temperature and humidity. M. Weltz, while occupied with the solution of the last questions, has arrived at the following conclusions:—He has remarked that the wood gradually blackens as the layers of metallic copper are produced on it. The sulphate of copper is fixed in the wood: this salt decomposes itself into metallic copper and sulphuric acid. The latter chars the wood, and it is through the layer of charcoal, the preserving agency of which has been so often remarked, that the wood is enabled to resist the action of humidity. M. Weltz's ideas are confirmed by the following fact:—In the south of Spain there exists an ancient copper mine (Mina de Riotonto) which dates from the first years of the Christian era. The woodwork which sustains the galleries is still in a perfect state of preservation. It is charred, a circumstance which is explained by the quantity of crystallised sulphate of copper and of metallic copper in regulus which covers it. The wood has remained exposed nearly 18 centuries to the action and humidity of the atmosphere, having been charred by the sulphate of copper while depositing metallic copper on its surface.

The Analysis of Iron, Cast-Iron, and Steel, in order to discover the presence of graphite, sulphur, and phosphorus (very injurious ingredients), is a difficult operation, liable to error and loss of material. The analytical difficulties do not consist in the treatment of these metalloids when once held in solution, but in bringing them to this condition. When a dissolving acid is employed it entails loss of sulphur and phosphorus, through the tendency of those substances to unite with hydrogen and form compound gases; and when the metal to be analysed has to be reduced to fine powder by a long and fatiguing operation, there is a danger of the introduction of foreign substances into the iron to be examined. In analysing some specimens of iron from some of the great French metallurgical establishments, M. Nickles has discovered a method of obviating these inconveniences, by employing bromine as a vehicle which possesses an action sufficiently powerful to dissolve the pieces of iron without causing any disengagement of gas. The bromine is diluted with a little distilled water; the iron passes into the state of a bromide; the sulphur passes into the state of sulphuric acid, easily treated with chloride of barium; and the phosphorus passes into the state of phosphoric acid.

Reduction of Chromium and Manganese.—In the course of some experiments with amalgam of sodium, the idea occurred to Mr. C. W. Vincent that it might be employed to advantage as a ready means of reducing some of those metals which are not readily obtained by ordinary metallurgical processes. By adding to a solution of the chloride of chromium an amalgam of sodium he found that, although there is a considerable waste of sodium, nevertheless an amalgam remains of chromium, which, on distillation in a tube retort filled with naphtha vapour, yields this metal in a finely-divided state. Mr. W. B. Giles, a very young chemist, has shown, in a note in the *Philosophical Magazine*, that when an amalgam of sodium is placed in a saturated solution of pure protochloride of manganese, a rapid action takes place, hydrogen is evolved, and finally an amalgam of manganese remains. He states that the same results appear to take place with cobalt.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTIZAN."

DATED SEPTEMBER 26th, 1862.

2624 W. Pettet—Covering for protecting vessels and forts from shot, shell, and other warlike missiles.
2625 J. J. Bates—Window sash fastener and guard.
2626 E. Dixon—Machinery and furnaces used in the manufacture of welded iron tubes.
2627 C. D. Abel—Purifying and preservative lotion for the mouth.
2628 J. M. R. D. Milner & F. Hurd—Apparatus applicable to machines for preparing wool, flax, and other fibrous substances.
2629 W. E. Gedge—Leaden window sashes, casements, or glazed coverings or partitions.
2630 W. M. Cochrane—Securing the bolts and nuts of railway fish plates.

DATED SEPTEMBER 27th, 1862.

2631 F. R. Stack—Escalading apparatus for military purposes.
2632 J. Crosby—Carding engines.
2633 H. Hutchinson—Machinery for covering wire with india rubber and gutta percha, and similar gums and compounds thereof, and for manufacturing tubes and other articles of such gums and compounds.
2634 M. Henry—Applications of petroleum and its products, certain agents produced by combining the same with other substances, and certain modes of treating caoutchouc, gutta percha, and their compounds, and substances similar thereto.

DATED SEPTEMBER 29th, 1862.

2635 J. C. P. Bauchard—Twice transversal kneading trough.
2636 H. Baum—Manufacture of moreens and such like fabrics.
2637 J. Brown—Carding engines employed for carding cotton and other fibrous substances.
2638 R. Griffiths—Construction of iron ships, and sheathing them with metal to keep them from fouling.
2639 M. Puddefoot—Apparatus for tilling land.
2640 W. B. Lord & F. H. Gilbart—Loading firearms and blasting.
2641 W. E. Gedge—Furnace for casting steel.
2642 J. E. Walker—Signalling on railways.
2643 H. Hirsch—Apparatus for showing combinations of colours
2644 H. Moule—Heating frames and the beds of hot houses.
2645 H. Ellis—Manufacture of compounds of silica, and the application of certain compounds of silica to mineralize woven fabrics, paper, and paper pulp, to harden and preserve stone and cement in the production of artificial stone and paint, and the production and glazing of porcelain and such like manufactures.
2646 J. Bucknall—Construction of horse hoes.
2647 J. Addison—Apparatus for securing articles, applicable also to the fixing of chairs for railways.
2648 R. A. Brooman—Saddle trees and collars
2649 J. H. Johnson—Shells for war purposes.
2650 W. Carrick & W. Carrick, jun. — Felting apparatus.

DATED SEPTEMBER 30th, 1862.

2651 R. Hoyle—Apparatus for printing surfaces of woollen, mohair, cotton, and other fabrics.
2652 E. J. M. le Bréton—Propeller for boats and ships.
2653—J. L. Hughes—Patterns in gold and colour on porcelain, earthenware, glass, and enamel.
2654 A. Prince—Manufacture of varnish, printing ink, paint, and printing colours.
2655 J. Wright—Rotative travelling crane.

DATED OCTOBER 1st, 1862.

2656 G. Haseltine—Mode of warming and ventilating buildings.
2657 P. G. V. Byl—Conserver brake for utilizing the power expended in stopping or retarding machinery, locomotive or other engines, and vehicles of any description when in motion.
2658 R. W. Greenwood & C. J. Marson—Mode of using the exhaust steam of steam engines by reconveying the same into the boiler.
2659 B. Donkin—Bearings for shafts, axles, pivots, and sliding surfaces for the purpose of diminishing friction.
2660 E. Lord—Power looms for weaving.
2661 W. C. Cambridge—Apparatus for washing clothes, applicable also as a churn.

DATED OCTOBER 2nd, 1862.

2662 J. Gilchrist—Boring engines, such as are used for mining purposes
2663 W. H. Ward—Night, day, and fog signals, and the means for effecting the same.
2664 W. C. Wilkins—Gas burners.
2665 E. S. & E. Habel—Machinery for preparing, spinning, and doubling fibrous materials.
2666 J. H. Johnson—Permanent way of railways
2667 G. J. Firmin—Treatment of certain salts of potash and lime.

DATED OCTOBER 3rd, 1862.

2668 F. Ensor & W. Payne—Apparatus for regulating the pressure of steam in steam boilers, and for indicating when the water in steam boilers is too high or too low.
2669 J. Harrop & J. Wadsworth—Deodorizing refuse, organic, fecal, and urinous matters, and a method of utilizing coal and other ashes, and machinery or apparatus connected therewith for producing a portable manure therefrom.
2670 T. J. Robotham & E. Oswald—Apparatus for purifying "glaze," "slip," or other potters' materials.
2671 R. Broadbent—Gas regulators.
2672 W. Clark—Atmospheric toy pistols and guns.
2673 W. Clark—Candlesticks.
2674 W. E. Gedge—Suction and life pump, and apparatus connected therewith.
2675 A. Dalrymple—Processes of depositing metals by galvanic action either with or without the aid of galvanic batteries, and the ornamentation of metal surfaces thereby.
2676 W. E. Gedge—Marquetry or veneer saw, and machinery connected therewith.
2677 T. Greenwood—Machinery for cutting staves.

DATED OCTOBER 4th, 1862.

2678 J. & W. Lee—Traction engines and boilers for traction, locomotive, and other purposes
2679 W. H. Muntz—Armour for the protection of ships of war and other vessels and fortifications from the effects of cannon shot and other projectiles.
2680 A. Barclay—Printing textile materials and fabrics, and machinery therefor.
2681 W. E. Gedge—Apparatus by the use of which pierced or perforated cocoons may be spun.
2682 S. Amphlett—Ornamenting surfaces of wood.
2683 J. E. Billups—Fixed points for railways.
2684 J. M. Cabriol—Submarine lamp.
2685 F. Parkinson—Ladies' shawls and cloaks
2686 F. Watkins—Apparatus for milking cows.
2687 F. E. Blatsfiel—Diving apparatus and apparatus to be used for working in deep water.
2688 W. Clark—Means for preserving goods from fire, and apparatus for the same.
2689 G. Whicker & L. Blaise—Skates, and the method of securing or fastening the same.
2690 F. Johnson—Domestic fire escapes, and receptacles for the same.
2691 W. Taylor & S. Buckley—Machinery for preparing cotton and other fibrous materials.

DATED OCTOBER 6th, 1862.

2692 R. Page—Stables and stabling applicable in part to kennels, and to the floors of fish houses.
2693 T. Keech—Floating batteries.
2694 J. & W. Badbury—Carding engines.
2695 D. Lowe—Door bolts and latches.
2696 S. Holland—Machinery for the manufacture of bricks, drain, sanitary, and other pipes, tiles, quarries, and other articles of like manufacture, made from clay, marl, and other plastic substances.
2697 W. Clark—Articles of clothing.
2698—J. Newnam—Apparatus for crystallizing and for evaporating.
2699 T. Beards—Machinery for cultivating land.
2700 S. F. Cox—Washing and tanning hides and skins.
2701 A. V. Newton—Apparatus for drying grain.
2702 C. Chiunock—Construction of axle-boxes.

DATED OCTOBER 7th, 1862.

2703 J. Heap—Screw stocks and dies.
2704 J. Smith—Screw linch-pin for carriages and agricultural implements.
2705 W. Aston—Manufacture of buttons for ladies' and gentlemen's wear
2706 J. Oxley—Apparatus for expressing and separating beer from yeast or barm.
2707 F. Rahles—Safety envelope.
2708—A. Forbes—Connecting together parts of vessels formed of tin plate, and the means or apparatus employed therein.
2709 J. D. W. & A. P. Welch—Machinery for blocking and pressing hats and bonnets.
2710 H. D. P. Cunningham—Working the guns and performing other necessary work on board ships, and apparatus employed therein.
2711 J. K. Hampshire — Machinery for washing coal, coal slack, and other mineral substances, and separating foreign particles therefrom.
2712 J. & M. A. Beale—Manufacture of manure.
2713 A. V. Newton—Construction of condensers or coolers.

DATED OCTOBER 8th, 1862.

2714 C. F. Terry—Machinery for propelling vessels.
2715 D. Nickols—Apparatus for measuring and registering lace and other similar articles.
2716 W. C. Burden—Mechanism for giving the pitch or tone required in tuning musical instruments, and also the key note of vocal music.
2717 T. Ratcliffe—Looms for weaving.
2718 P. Clavel—Treatment of violet colours derived from coal tar oils.
2719 J. R. Harris—Propelling vessels.
2720 M. A. F. Mennons—Self-inking hand stamps.

DATED OCTOBER 9th, 1862.

2721 H. Dullens—Runner and fastening for umbrellas, parasols, sun shades, and other like articles.
2722 J. Maurice—Steering ships or vessels, and the apparatus to be employed for that purpose.
2723 W. Bush—Cannon and small arms.
2724 C. N. Wilson—Rag machines
2725 J. H. Johnson—Polishing precious and other hard stones, and the machinery employed therein.
2726 J. H. Johnson—Manufacture of paints or pigments.
2727 R. Hammond—Armour for ships of war.
2728 A. V. Newton—Machinery for breaking and cleaning flax, hemp, and other like fibrous substances.
2729 J. B. Palmer—Apparatus for manufacturing paper pulp and recovering the alkali used in such manufacture.
2730 G. Simons—Manufacture of plates, rods, axles, tyres, and other articles that are required to be partly of iron and partly of steel.

DATED OCTOBER 10th, 1862.

2731 L. Hosch—Constructing travelling trunks and portmanteaus.
2732 W. & S. Schofield—Apparatus for cutting button holes and other similar purposes.
2733 R. E. Green & J. Cockcroft—Materials forming a substance suitable for printers' blankets, conductors used in paper making, and packings for joints.
2734 G. Baguley & H. Greener—Construction of insulator for telegraph wires.
2735 J. Lowe and J. Harris—Propeller.
2736 H. A. Marinoni—Apparatus for fixing type in chases.
2737 W. C. Edge—Velocipedes.
2738 D. S. Sutherland—Constructing beams, girders, bridges, and viaducts.
2739 W. Wealleus—Surface condensers for marine and other engines.
2740 T. Anderson—Construction of ships or vessels.

DATED OCTOBER 11th, 1862.

2741—J. J. Shedlock—Gas-metres.
2742 E. J. Frankiin—Combined spring tape measure needle case and pin cushion.
2743 A. Vennedy—Composition for covering and forming the tips of umbrellas and parasols, also applicable to covering the ribs and stretchers of the same.
2744 R. A. Brooman—Breech-loading fire-arms.
2745 W. Catchpool—Fire escapes.
2746 J. Durant—Construction of chimney tops or appliances for surmounting chimneys.
2747 T. Bouch—Apparatus for charging or filling cartridges
2748 A. V. Newton—Evaporating apparatus applicable to the manufacture of sugar.
2749 A. V. Newton—Sewing machines.

DATED OCTOBER 13th, 1862.

2750 S. Chatwood—Fire and thief-proof depositories.
2751 G. H. & A. Harvey, jun.—Boring machinery.
2752 A. F. Gallis—Covering street omnibuses and other vehicles.
2753 G. Haseltine—Jacks and screw nuts for attaching thills and poles of waggons and other vehicles to the axle trees of the same.
2754 C. McCarthy—Automatic safety valves.
2755 W. Loeder—Projectile to be used with ordnance or fire-arms of any calibre
2756 C. Thomas—Manufacture of silicate of soda, or silicate of potash, and in the manufacture of artificial stone
2757 W. G. Haig—Apparel to be worn instead of or in addition to a shirt front and waistcoat.
2758 J. Gumbley—Break for vehicles travelling on common roads.
2759 A. L. Mahon—Propellers and paddle floats, also applicable to the raising and forcing of water or other fluids.
2760 E. B. Wilson—Apparatus employed in the manufacture of iron and steel.
2761 S. Smith—Kettles, saucepans, and boilers.
2762 F. G. Grice—Manufacture of nuts for screwed bolts, and machinery employed in the said manufacture.
2763 E. Suckow & E. Habel—Apparatus for preparing, spinning, and doubling cotton and other fibrous materials.
2764 H. Bridson & J. Alcock—Machinery for folding, measuring, and hooking woven fabrics.
2765 E. Barlow, J. Clough, & F. Hamilton—Machinery for driving cotton gins, and for preparing and combing cotton and other fibrous substances.
2766 J. Suid r, jun.—Construction of Hansom cabs, and other similar vehicles.
2767 C. Harratt—Ships' masts.
2768 D. & C. J. Reid—Manufacture of cases for watches and other pocket timekeepers.
2769 M. Cartwright—Plates for artificial teeth.
2770 R. A. Brooman—Apparatus for carburetting gas.
2771 R. A. Brooman—Dressing millstones, and machinery employed therein.
2772 E. H. C. Monckton—Coils of inductions, and obtaining and applying power by means of electro magnetism.
2773 O. J. & J. Showell—Construction of glass roofs and roof lights.
2774 S. Healey—Manufacture of zinc.
2775 J. H. Johnson—Sewing machines.

DATED OCTOBER 15th, 1862.

2776 E. Molyneux—Carriage, with a travelling railway attached.
2777 W. Wilson—Oblong drawing room bagatelle and billiard table.
2778 J. H. Jenkinson—Drinking fountains.
2779 J. Taylor—Temples for looms.
2780 C. de Bergue—Apparatus for the crushing and treatment of ores.
2781 C. de Bergue—Permanent way of railways.
2782 W. Pope—Coating the sides of ships, forts, batteries, or other places with defensive armour plates.
2783 P. Potenza—Extraction, preparation, and spinning of the silky fibre contained in the bark of the mulberry tree, and the manufacture of the same into textile fabrics.
2784 J. B. G. M. F. Piret—Lubricating apparatus.
2785 F. F. Prud'homme—Apparatus for raising water.
2786 J. Bapty—Apparatus for preparing wool and other fibrous materials.
2787 R. A. Brooman—Felting machines.
2788 R. A. Brooman—Refrigerating and freezing apparatus.
2789 E. A. Cowper—Steam engines.

DATED OCTOBER 16th, 1862.

2790 W. Burningham—Permanent way of railways.
2791 G. Berry—Locks.
2792 G. T. H. Pattison—Machinery for embossing or finishing woven fabrics.
2793 G. T. H. Pattison—Imparting a new surface or appearance to fabrics woven with mixed materials.
2794 H. A. Remière—Horse collar.
2795 F. Delmas—Rain absorber.
2796 T. G. Harold—Locks
2797 E. Humphrys—Steering apparatus.
2798 H. Ranstord—Building ships and other vessels.
2799 J. Cash & J. Cash, jun.—Manufacture of valentines.
2800 J. Robinson—Protecting the submerged portions of iron ships, and ventilating the cabins and cabin decks in iron ships
2801 E. Stely, G. Mills, & Co.—Envelopes.
2802 E. Nelson—Apparatus for heating and superheating steam and air without decomposition.

DATED OCTOBER 17th, 1862.

2803 J. Summerton—Harrows.
2804 H. Wickens—Nails.
2805 J. Davies—Rotary engines.
2806 W. S. Kennedy—Applying fomentations.
2807 G. T. Bousfield—Manufacture of iron and steel.
2808 J. H. Johnson—Removal of incrustation from steam generators.

DATED OCTOBER 18th, 1862.

2809 R. Webster—Preventing railway accidents.
2810 E. Lord—Opening and cleaning cotton.
2811 H. Ledger & B. Williamson—Tombstones, &c.
2812 J. Bentley—Pressing felt hats.
2813 B. Lauth—Polishing sheet iron.
2814 R. A. Brooman—Twisting threads.
2815 J. Fuller—Treating of India rubber on wires.
2816 W. E. Gedge—Extracting condensed steam.
2817 W. Clark—Dredging.

DATED OCTOBER 20th, 1862.

2818 J. Tangye—Pulleys.
2819 G. Haseltine—Forging cannon.
2820 R. A. Brooman—Transferring designs.
2821 J. Clark—Railway brakes.
2822 N. R. Hall & M. L. Parnell—Thermometers.
2823 W. A. Turner & T. T. Coughin—Measuring cloths.
2824 J. B. Payne—Spinning and twisting hemp, &c.
2825 H. L. Emery—Endless chain railway horse powers.
2826 J. H. Johnson—Boiling liquids and cooking food.

DATED OCTOBER 21st, 1862.

2827 W. Butlin—Splitting leather.
2828 W. Tristram—Dressing yarns or threads.
2829 W. H. Tucker—Self-closing apparatus for doors.
2830 J. Bryam—Lamps.
2831 S. Whitham & T. Wright—Iron and steel.
2832 C. G. Clarke, jun.—Garden shears.
2833 C. Clark—Cigar tubes.
2834 J. T. Cooke—Battens for weaving.
2835 R. A. Brooman—Water-proofing.
2836 G. T. Bousfield—Boots and shoes.
2837 J. Duke & J. Clever—Cement.
2838 G. Haseltine—Nails and brads.
2839 F. Tolhausen—Raising and lowering buildings.
2840 C. Trees and F. C. Belhomme—Hats, caps, &c.

DATED OCTOBER 22nd, 1862.

2841 G. Clark—Construction and armament of ships
2842 J. Spence—Non-conducting compositions.
2843 C. Webster—Self-acting fountains.
2844 E. Fielding—Healds
2845 H. Wilde—Electro magnetic telegraphs.
2846 H. H. and J. F. G. Kromschroder—Gas metres.
2847 E. W. Hughes—Turntables and bridges.
2848 T. Fearn—Furniture.
2849 T. Greenwood—Machinery for preparing to be spun flax and other fibrous substances.
2850 V. Orlowski—Motive power carriages.

DATED OCTOBER 23rd, 1862.

2851 J. T. Stroud—Lamps.
2852 W. S. Gamble—Salinometer.
2853 A. Chaplin and G. Russell—Obtaining fresh water by evaporation.
2854 J. Turnbull—Mills for grinding grain.
2855 W. Clark—Sewing machines.
2856 E. Bath—Alkali waste.
2857 M. C. A. Perkes—Double-acting rudder.
2858 H. Rée—Apparatus for exercising the human body.
2859 H. Donald—Bending or straightening plates.
2860 E. H. Carbutt and G. A. Clough—Hammers.
2861 J. Fiel—Steam engines.
2862 R. A. Brooman—Tanning.

DATED OCTOBER 24th, 1862.

2863 A. J. F. Vigneulle-Brepson—Siphoidal cistern, with water reservoir for kitchen or other drains in communication with infected sewers
2864 C. C. Burmeister and W. Wain—Cupolas.
2865 L. Groux—Manufacture of soap
2866 J. Gunson and R. Flude—Looms for weaving narrow fabrics.
2867 J. R. Nichol—Fireplace or stove grate.
2868 J. Wright—Construction of seamless stays.
2869 J. T. Stroud—Machinery for holding, drilling, turning, tapping, fitting, and shaping certain parts of steam, water, gas, and lamp fittings.
2870 P. S. Devlan—Manufacture of bearings, steps, axle boxes, and other articles subjected to friction

DATED OCTOBER 25th, 1862.

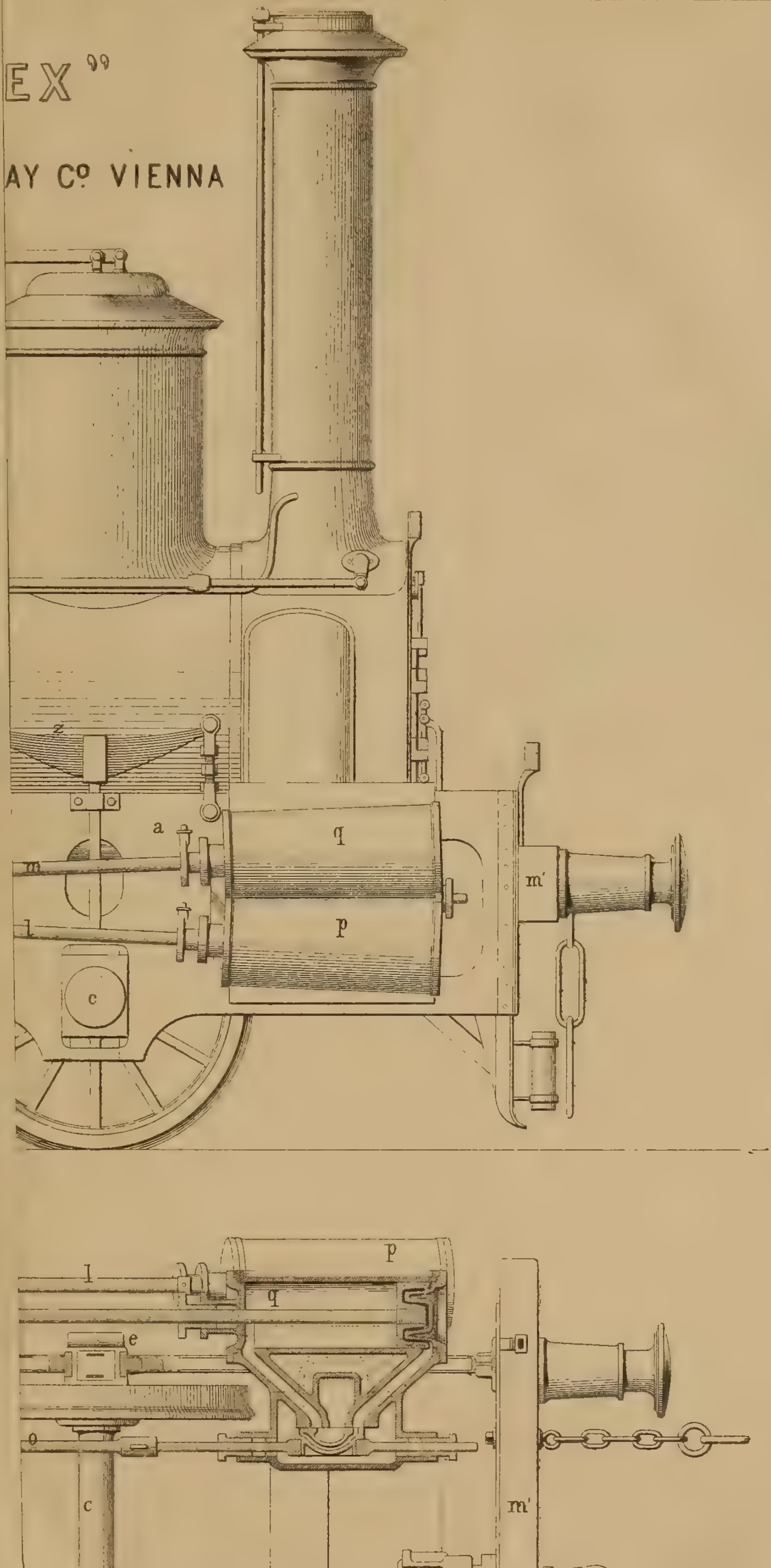
2871 G. and W. Luke—Buckle eye stirrups.
2872 J. Carpendale—Producing raised chasing on Britannia and other compressible metals.
2873 W. Owen—Stoves.
2874 G. T. Key—Fog and other signals.
2875 D. and W. Brown—Machinery for rolling gun barrels, cannons, and other articles.
2876 J. A. Nicholson—Lead and other pencils.
2877 W. Clark—Construction of the joints of cast iron gas and other pipes.
2878 A. Clark—Bows and pendants of watches
2879 P. Alfraise—Sewing machines
2880 T. G. Ghislin—Treatment and utilization of foreign plants for the obtaining of fibres therein
2881 E. A. L. Negretti and J. W. Zambra—Apparatus for testing the explosibility of liquid hydro carbons
2882 J. P. Bourquin—Mount for photographic pictures

DATED OCTOBER 27th, 1862.

2883 J. Chattwood—Ventilating rooms and cellars
2884 J. H. Johnson—Rotatory engines
2885 J. H. Johnson—Heating glass furnaces
2886 H. C. R. Joubert—Raising music chairs, stools, or seats
2887 F. Lipscombe—Purifying water
2888 W. J. Williams—Construction of field rakes
2889 T. Pilgrim—Locks, bolts, and other fastenings
2890 F. L. H. W. Bunger—Self-acting apparatus for discharging the water resulting from the condensation of steam
2891 J. J. Ridge—Treating farinaceous substances applicable to infants' and invalids' food
2892 P. E. Placet—Engraving
2893 G. Lindemann—Manufacture of bricks, tiles, slabs, and other articles
2894 A. Peck—Apparatus for evaporating saccharine and saline solutions
2895 T. Richardson—Manufacture of sulphate of soda
2896 J. Howie—Apparatus for regulating the supply of solid or liquid bodies to mills, and mixing or preparing plastic matters

EX"

AY Cº VIENNA



EXPRESS LOCOMOTIVE "DUPLEX"

CONSTRUCTED AT THE WORKS OF THE I.R. AUSTRIAN STATE RAILWAY Co. VIENNA

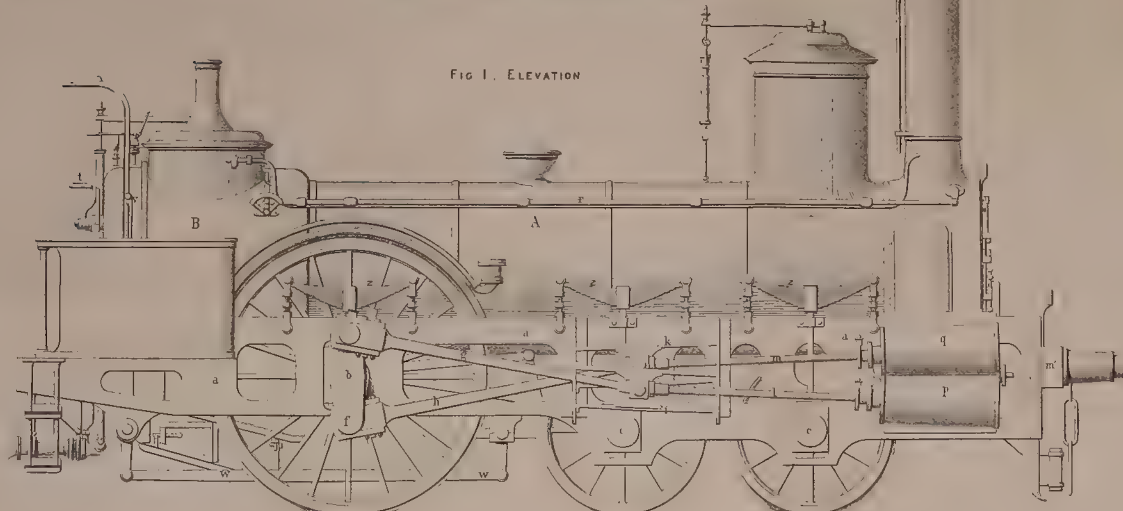


FIG 1. ELEVATION

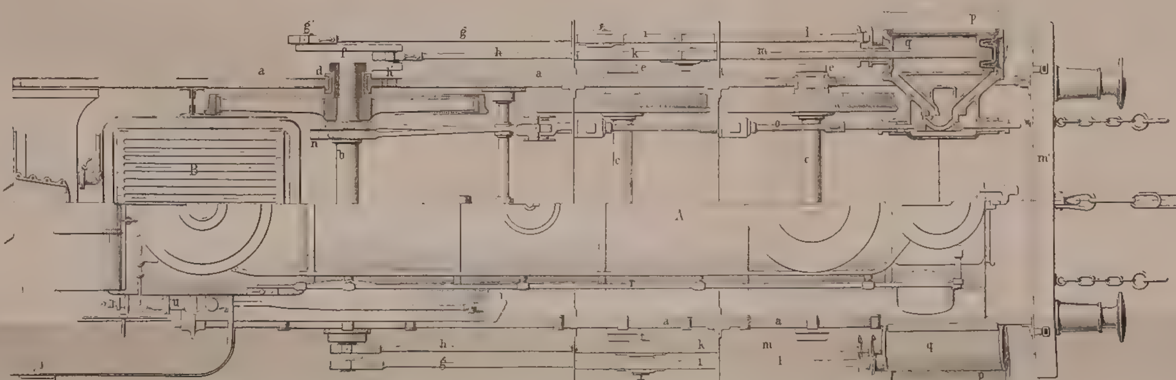


FIG 2 HORIZONTAL SECTION

FIG 3 PLAN

THE ARTIZAN.

No. 240.—Vol. 20.—DECEMBER 1, 1862.

EXPRESS LOCOMOTIVE "DUPLEX."

Designed by Mr. John Haswell.

Constructed at the Works of the I. R. Austrian State Railway Co., Vienna.

(*Illustrated by Plate* 226.)

This locomotive was designed for express trains, to pass at gradients of 1 : 150 and curves of 930ft. radius, without causing any disturbance or damage to the rails, The arrangement of the cylinders and the slide valves is due to Mr. Haswell, the manager of the Company's works. In our plate, fig. 1 is a side elevation, fig. 2 a half of the horizontal section, and fig. 3 a half plan of this engine. A is the tubular boiler; B the fire-box, containing $\frac{1}{16}$ of the heating surface; *a* is the outside framing, supported by the springs *z*; *b* is the axle of the driving wheel; and c c^1 the leading wheel axles; *d* the bearings of the driving axle; e e^1 the bearings of the axles of the leading wheels. The bearings of the driving axles are made according to Hall's patent, which allows of the centres of the cylinders being brought closer to the framing than could otherwise be secured; *g h* are the connecting rods, the crossheads of which slide in the guides *i k*; the cylinders *p q* are cast in one piece; the slide valves are worked by thhe eccentrics *n n* and rods *o o*; the details of their arrangement will be better understood from the accompanying woodcuts and description of the arrangement of cylinders and slide valves. The two cylinders on each side are disposed one above and the other below a horizontal plane drawn through the centre of the driving axle. The axes of each pair of cylinders cut one another at the centre of the driving axle, forming an angle of 2° 30′.

In the accompanying woodcuts, Fig. 1 is a vertical section taken through the slide valve chest, the slide valve and the two cylinders on the lines *c c* at figs. 2 and 3; fig. 2 being a section through A A, fig. 1; and fig. 3 a horizontal section taken through B B, fig. 1. In these three views the pistons are shown at the middle of their stroke, and the arrows denote the direction of th eir motion at the time and the passage of the steam. In fig. 1, *z* is the induction passage to the slide valve chest, and *x y* the eduction passage. The induction passage is divided into two parts by the diaphragm *t*, making four steam passages instead of two—viz., *u* and u^1 above, and *v* and v^1 below the diaphragm. These steam passages are so formed, that when the steam enters at *z* into the slide chest, passing at *u* and *v* into the two passages, and leaving by u^1 v^1, the passage *u* directs the steam into the cylinder *p* on to the top of the piston and the passage *v* to the bottom of the piston of the cylinder *q*, likewise the passages u^1 and v^1 direct the steam in opposite directions; the slide valve being reversed, the steam enters the cylinders through *u, v*.

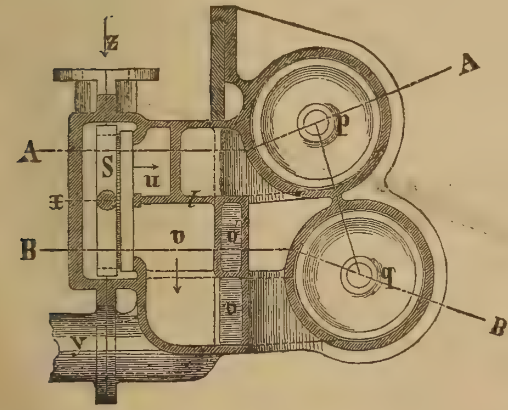


Fig. 1.

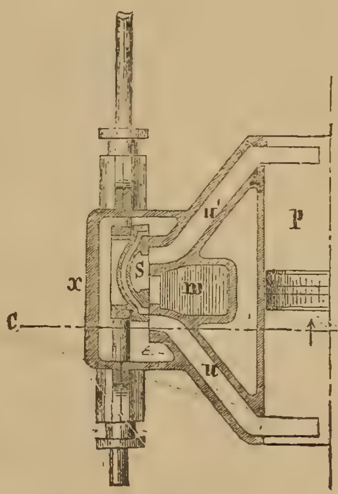


Fig. 2.

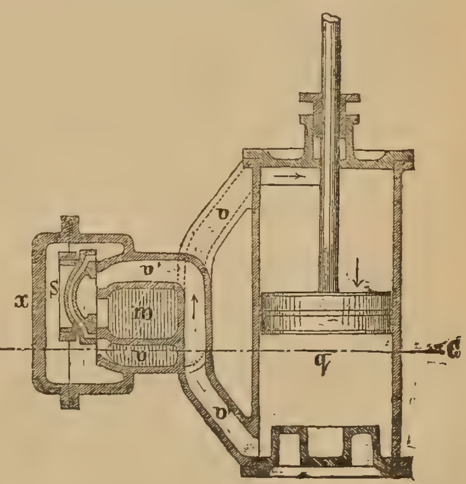


Fig. 3.

The following are detailed particulars of the dimensions of the several parts of the engine and boiler :—

Firegrate.

Length	4ft. $3\frac{3}{16}$in.
Width	3ft. $7\frac{7}{8}$in.
Area	15·06 sq. ft.
Grate bars	21 pieces.
Distance af the bars from each other	$\frac{15}{16}$in.

Firebox.

Length inside at the bottom	4ft. $3\frac{3}{16}$in.
,, at the top	4ft. $\frac{11}{16}$in.
Width inside at the bottom	3ft. $7\frac{7}{8}$in.
,, at the top	3ft. $6\frac{7}{8}$in.
Height inside, fore part	4ft. 10in.
,, back part	3ft. $9\frac{9}{16}$in.
Height from the fire door to the bottom of the firebox	2ft. $1\frac{3}{8}$in.
Thickness of copper plates	$\frac{5}{8}$in.
,, of the tube plate	$1\frac{1}{32}$in.

Barrel of the Boiler.

Length up to the tube plate in the smoke chamber	14ft. $2\frac{1}{16}$in.
Largest diameter	4ft. $\frac{3}{4}$in.
Smallest ,,	3ft. $10\frac{11}{16}$in.
Thickness of boiler plate	$\frac{1}{2}$in.
Diameter of rivets	$\frac{3}{4}$in.
Distance of rivets apart	$1\frac{13}{16}$in.
Thickness of iron tube plate	$\frac{7}{8}$in.
Number of tubes	160
External length of tubes	14ft. $6\frac{1}{4}$in.
Internal diameter of tubes	$2\frac{1}{16}$in.
Thickness of brass of the tubes	$\frac{3}{32}$in.
Distance from centre to centre of the tubes	$2\frac{11}{16}$in.

HEATING SURFACE.

Tubes	1260 sq. ft.
Firebox	84 sq. ft.
Total heating surface	1344 sq. ft.

CHIMNEY.

Diameter	1ft. $4\frac{1}{2}$in.
Height from the rails	15ft. $3\frac{1}{16}$in.

BLAST PIPE.

Area of the largest aperture	25·8 sq. in.
„ of the smallest aperture	4·8 sq. in.

STEAM CYLINDERS.

Interior diameter	$10\frac{7}{8}$in.
Length of stroke	2ft. $\frac{7}{8}$in.
Inclination of cylinders	2° 30′.
Horizontal distance from centre to centre of the upper cylinders	7ft. $2\frac{1}{16}$in.
Horizontal distance from centre to centre of the lower cylinders	7ft. $11\frac{9}{16}$in.
Horizontal distance of the two cylinders on each side	$4\frac{3}{4}$in.
Length of steam ports	1ft. $\frac{7}{16}$in.
Width of „	$1\frac{9}{16}$in.
„ exhausts	$3\frac{5}{32}$in.

SLIDE VALVES AND REVERSING GEAR.

External length of slide	$11\frac{3}{16}$in.
Internal „ „	$4\frac{11}{16}$in.
External width of slide	1ft. $3\frac{9}{16}$in.
Internal „ „	1ft. $\frac{7}{16}$in.
Area of slide valve	173 sq. in.
Largest aperture for induction of steam	$1\frac{1}{32}$in.
„ for eduction	$1\frac{9}{16}$in.
Largest travel of slide	$4\frac{11}{16}$in.
Length of eccentric rod	4ft. $9\frac{9}{16}$in.
Radius of segment at centre	4ft. $9\frac{9}{16}$in.
Length of segment	1ft. $4\frac{1}{16}$in.

CONNECTING RODS.

Length	7ft. $3\frac{1}{8}$in.

WHEELS.

Number of wheels	6.
Diameter of driving wheel	6ft. $8\frac{7}{8}$in.
„ supporting wheel	4ft. $1\frac{3}{4}$in.
Width of tyres	$5\frac{7}{16}$in.
Taper of tyres	$\frac{1}{16}$in.
Total length of wheel base	11ft. $4\frac{7}{8}$in.
Distance between the supporting wheels	4ft. 8in.

TENDER.

Capacity for water	301 cubic ft.
„ fuel	257 „

BUFFERS.

Height above the rails	2ft. $6\frac{1}{2}$in.
Distance from centre to centre	5ft. 9in.

MISCELLANEOUS.

Total length of engine	27ft. $5\frac{1}{4}$in.
Total width	5ft. 9in.
Weight on rails from the first supporting axle	9·84 tons.
„ „ second „	9·54 „
„ „ third „	12·30 „
Total weight of engine when at work	31·68 „

At some recent trial trips this locomotive drew a train of 4·9 tons at a speed of 66 miles per hour with the greatest steadiness, whereas the locomotive "Rokitzan," similar to the "Duplex," but being furnished only with one pair of cylinders, could not exceed 56 miles without disturbance.

We may state that a prize medal was awarded by the jury of class 10 of the International Exhibition to the I. R. Austrian State Railway Company. for this locomotive, as being specially adapted for steep inclines and sharp curves, and for its excellence of workmanship.

USEFUL NOTES AND FORMULÆ FOR ENGINEERS.

(*Continued from page* 246.)

PRIME MOVERS.

The unit of work is one horse power, or 33,000 lbs., raised one foot per minute.

Let P represent the actual pressure of steam per square inch on the piston, p the resistance per square inch, caused by the exhaust steam on the opposite side of the piston, both in pounds, N the number of strokes per minute, and l the length of the stroke in feet, and a the area of the piston; then, if we represent the actual horse power by H a,

$$H\,a = \frac{(P - p)\,a\,.\,l\,.\,N}{33000}$$

which is the work done upon the piston.

To ascertain the mean pressure upon the piston, indicators are connected with the top and bottom of the cylinder, which register the pressure at every part of the stroke, from which register the mean pressure may be found; the diagram drawn by the indicator is also valuable as showing accurately the action of the slides.

The nominal horse power of an engine is usually far less than the actual horse power, being determined by a measurement of the cylinder without regard to the pressure at which it is intended to be worked, although a pressure is determined upon which the formula depends, thus for condensing engines the value of $(P - p)$ is very generally taken at 7 lbs.

The nominal horse power provides the data by means of which engines may be compared as to commercial value, the price being usually fixed at per horse power.

The following are some of the formulæ used for determining the nominal horse power of engines,—

a = area of piston in square inches.
d = diameter of piston in inches.
Hn = nominal horse power.

Condensing Engines.

Watts's Rule.

$$H\,n = \sqrt[3]{\text{stroke} \times d^2}$$

Manchester Rule.

$$H\,n = \frac{a}{23}$$

Leeds Rule.

$$H\,n = \frac{d^2}{30}$$

Non-Condensing Engines.

Manchester Rule.

$$H\,n = \frac{a}{10}$$

Leeds Rule.

$$H\,n = \frac{d^2}{16}$$

The power of steam boilers may be safely calculated at one horse power for every square yard of heating surface and square foot of fire surface, this being sufficient to evaporate one cubic foot of water per hour. For cylindrical boilers, with the fire underneath, the horse power is equal to one-fifth the horizontal section; or if

l = length in feet
d = diameter in feet.

$$H = \frac{d\,l}{5}$$

if there are flue tubes as well, their section must be added to that of the boiler.

The efficiency of vertical heating surface is only half that of horizontal surface above the fire.

With regard to the capacity of boilers, 27 cubic feet per horse power is economical.

The Lancashire rule allows one cubic foot of boiler room for every square inch of piston.

The North Country rule allows a cubic foot of boiler room for every circular inch of piston.

WATER WHEELS.

Let Q = the quantity of water supplied per second, in cubic feet.
w = the weight of a cubic foot.
V = the supply velocity, in feet per second.
v = the discharge velocity, in feet per second.
h = the difference of head of water before and after its action on the wheel, in feet.
N = the number of pounds raised one foot per second.

The total energy of the water is,

$$N = Q\,w\left\{h + \frac{V^2}{2g}\right\}$$

the energy of the water when discharged,

$$N = Q\,w\,\frac{v^2}{2g}$$

the power impressed upon the wheel,

$$N = Q\,w\left\{h + \frac{V^2 - v^2}{2g}\right\}$$

$$h + \frac{V^2}{2g}$$

represents the theoretic head which we will call h_1.

The limit to the efficiency of the machine is evidently,

$$Q\,w\left\{h + \frac{V^2}{2g}\right\}$$

but it is usually far removed from this.

We will represent the co-efficient for reducing the total power of the water to the available power by c; then calling H the horse power of the machine,

$$H = 0{\cdot}1227 \,.\, c \,.\, Q\,h$$

The usual velocity of overshot and breast wheels is from three to six feet per second.

Turbines are usually of small diameter; they work under great heads, one erected at St. Blasien working under a fall of 354 feet, producing 0·75 of the power expended upon it, it would make 2300 revolutions per minute. Turbines seldom have a velocity less than one-half or one-third of that due to the fall.

The values of c for the various forms of water wheel are as under—

Breast wheels ... / Overshot wheels	0·75 to 0·85
Undershot wheels, radial floats......	0·30
Undershot wheels, curved floats ...	0·60
Turbines	0·70 to 0·90

A CRITICAL AND HISTORICAL REVIEW OF LOCOMOTIVE ENGINEERING.

By J. J. Birckel.

To carry our thoughts back to the days which have witnessed the birth and infancy of the mechanical contrivance whose unexpected performances have completely revolutionised the social conditions of humanity and proved to man no less a source of power than of comforts—to trace its gradual development through the various changes which it has undergone, both in its general outlines and in the minor details of its mechanism, until we find it in its present comparative state of perfection—must be to us at once a pleasing duty and an instructive task. It seems to us a duty to make ourselves acquainted with the early struggles of the fathers of our profession, so far as that is possible from a contrast of the various productions of their minds (at first necessarily untutored in the science of practical engineering)—in order to render ourselves familiar with the extent of the debt we owe them for the present condition of that science, and for the manifold comforts and enjoyments of life which, as a natural consequence, accrue therefrom to all classes of men; lest, through ignorance of these facts, we should overestimate our own worth, and become alike ungrateful to the memory of the past, and to the few remaining links which tie the present generation to the one now nearly extinct, which, having to create and to originate everything, has left us masters, as it were, of the material universe. It cannot fail to be eminently instructive to us, tutoring our minds in the ways of nature, teaching us that excellence can only be attained by repeated and successive improvements, and that truth is only arrived at by thoughtful and diligent research.

Various works have been published on the subject of locomotive engineering, each embodying a valuable amount of information of its kind; and were we to suppose the generality of students in mechanical science possessed of a knowledge of this subject in proportion to the amount of information such works are intended to convey, we should, perhaps, abstain from writing these pages, which, in that case, might well be considered to have no practical value. The works alluded to, however, are generally so abstruse—if not in the matter treated of, at any rate in the manner in which it is presented to the reader—as to cause the latter to look upon it, at a first glance, as being something beyond the reach of his comprehension, while at the same time, also, they are often so costly as to render their acquisition a matter of serious consideration to many an earnest student and enquirer after truth.

These considerations alone would be sufficient to justify us in presenting our readers our readers with a series of papers, historical and critical, upon a subject of which Mr. D. K. Clark very elegantly says "that it implies not only a problem to solve, but also an object of enduring admiration to describe." But a careful study of the various works treating upon this subject have revealed to us the somewhat humiliating fact, that at the present stage of the developement of our railway system, we are but very imperfectly acquainted with the law of resistance of trains, or, in other words, with the amount of power to be developed by an engine in the performance of a certain duty, while a no less careful study of that engine itself has proved to us that there still exists, among locomotive engineers, many different and sometimes conflicting opinions on various details of construction; and thus we have been strongly impressed, with a conviction that the subject requires to pass through the hands of the critic in order to bring it to the cognisance of some competent mind, willing and able to investigate and finally establish the laws of train resistance.

The locomotive engine is, perhaps, in some respects, the most complete piece of machinery yet devised by the mind of man: it is at once a steam generating apparatus, a duplex steam engine and a large carriage; and as the problems to be solved must of necessity be proportionately complex, we need not wonder that different authorities should have arrived at different conclusions or results. To us the problems to be solved appear as follows:—

1. To define the nature and amount of resistances the engine has to overcome in the performance of a certain duty.
2. To provide boiler, or steam power, sufficient for the performance of that duty.
3. To provide an engine capable of evolving that power in the most economical manner possible.
4. To put both engine and boiler upon a well constructed carriage.

We shall pursue our investigation in the order just named.

The first experiments sufficiently comprehensive to lead to a fair though still imperfect knowledge of train resistances, are those made by Pambour on the Manchester and Liverpool Railway, in 1836, recorded and discussed in his well-known work on the locomotive engine, for many years the only work published on this subject, and in which that question has been treated in such a masterly manner as must, even unconsciously direct or guide the minds of any future experimentalists or writers on the same subject. Nothing, indeed, could be freer from reproach than the order pursued in the investigation of the question: first, determining the resistances of the train itself as arising from the atmosphere, from friction proper and from gravity, and, afterwards, determining the resistances of the engine itself, as arising from the friction due to its own weight, from that due to the resistance of the train, from gravity and from the blast pipe; while at the same time the method pursued to define the frictional resistance of the train is such as must fill with pleasure and admiration any mind possessed of a keen appreciation of the beautiful in applied mathematics. Mr. D. K. Clark, though he acknowledges in the preface to his work on Railway Machinery, that Pambour's treatise bears evidence of a mind imbued with the spirit of a philosophical research, has altogether ignored it in his chapter on train resistances; and yet in taking distinct cognisance of train and engine resistances, it seems to us that he does but follow in the track cut out by Pambour; nor does he improve upon the latter when he lumps into one item the various resistances due to the atmosphere, to friction, and to concussion.

For the total atmospheric resistances Pambour gives the following formula:—

$$R\,a = 0{\cdot}002687\,v^2\,(70 + 10\,n)$$

where it is assumed that an ordinary waggon has an area of 70 sq. ft. on an average, wheels and axles included, and that every succeeding waggon offers for effective resistance an area of 10 sq. ft. These data, which are deduced from direct experiments, no doubt are tolerably correct, especially for luggage trains; but his estimate of the resistance per square foot no doubt is too low; for while he gives it at 1·07lb. for a speed of 20 miles per hour, 4·3lbs. for 40 miles, and 6·7lbs. for 50 miles, Morin gives them respectively at 2lbs., 8lbs., and 12lbs. nearly; and as these amounts are deduced from later experiments, we are inclined to think that they are a nearer embodiment of truth. As the formula quoted, however, assumes the train to move in a calm atmosphere, it could scarcely, even with these modified figures, be assumed to give correct amounts for the ordinary circumstances under which railway traffic is carried on; for as soon as there is a strong wind, and especially if it is a side wind, the engine has to overcome resistances which this formula does not take into account. This may be plainly illustrated from the report of Mr. Gooch's experiments on the broad gauge, where we find that a train moving at a speed of 43 miles in calm weather offered a resistance of 12·35lbs. per ton, while a similar train moving at a speed of 44 miles, with a strong side wind of 8·89lbs. per square foot, offered a resistance of 16·69lbs. per ton, showing a difference of more than $\frac{1}{3}$ the first amount; and in the same record we find that a train moving in calm weather at the rate of 56·8 miles, offered a resistance of 17lbs. per ton; while a similar train, moving at a speed of 57.4 miles, with a strong side wind of 12lbs. per square foot, offered a resistance of 20·11 per ton, showing a difference of $\frac{2}{11}$ of the first amount. Here, therefore, Pambour is defective, not in his method, but in his amount; because the experiments upon which he has grounded his conclusions are too few in number, and do not take into account the various disturbances of the atmosphere, against which, perhaps in nine cases out of ten, the engine has to contend.

Later writers on the subject have felt this defect, and Mr. Sewell, in his edition of Tredgold (1850), has endeavoured to construct a more comprehensive formula from the data supplied by Mr. Gooch's experiments, to which we have already referred. The two cases, however, which we have adduced, are the only ones in the whole series from which he could draw any fair conclusion as to the effect of side winds on the resistance of trains, and to construct a formula from such meagre data is at best a very hazardous undertaking, from which every public teacher is in duty bound to abstain. To make the matter worse, Mr. Sewell has started from the very erroneous assumption that the resistance in question is proportional to the cubic contents of the train, and his formulæ reads as follows :—

$$R\,a = V^2 \times B \times 0{\cdot}00002$$

where B is the bulk of the train in cubic feet and V the speed in miles, although it seems that common sense, without the aid of direct experiment would teach that this resistance is entirely superficial, and bears no relation to the cubic contents of the moving mass. Mr. D. K. Clark on the other hand acknowledging the insufficiency of the data he had to work from, has not even attempted specifically to define the atmospheric resistances. We will presently call attention to his general views on the subject, when speaking of frictional resistances. In order to determine these, Pambour first tried the dynamometric indicator, but finding the results very uncertain, he afterwards had recourse to the method of running the trains down two inclines of different declivity, measuring the distances run over on each incline as well as the vertical heights through which the train had descended, and then, by calculation finding the amount of frictional resistance. For the analytical investigation of this subject, which it would be out of place here to reproduce, he carefully introduces all the elements which retard the motion of the train, and after some very elegant algebraic transformations, lays down the following formula for the co-efficient of friction :—

$$f = \frac{h + h'\,Y}{l + l'\,Y} \quad . \;.\; .\; .\; . \quad (1)$$

where f is the amount of friction per ton, h and h' the respective vertical heights through which the train has descended on the given inclines of which l and l' denote the respective portions in length, over which it has run (l' being the incline upon which the train finally stops), and Y is a factor obtained by purely theoretical considerations, containing chiefly the elements of atmospheric resistance, and which in the circumstances under which Pambour made his experiments, had the numerical value of 1704. In the course of his calculations, and in order to prove their correctness, he remarks that if the train moved *in vacuo* (in which case friction would be the only retarding force to the motion of the train), the above formula would simply stand thus :—

$$f' = \frac{h + h'}{l \times l'} \quad . \;.\; .\; .\; .\; . \quad (2)$$

and this statement may readily be demonstrated in the following manner : the mechanical work accomplished during the descent, is equal to the product of the load by the sum of vertical heights through which it has travelled, and it is equal also to the product of the co-efficient of friction by the total load, and by the distance over which it has travelled ; if W be the load it may symbolically be put into the following equation,

$$W \times (h + h') = f'\,W \times (l + l')$$

whence

$$f' = \frac{W\,(h + h')}{W\,(l + l')} = \frac{h + h'}{l + l'}$$

which demonstrates Pambour's statement.

When, therefore, the method of inclines is adopted to determine this co-efficient, under the influence of the atmosphere, without introducing into the formula the factor Y, the result does not express friction proper, that is, axle and rolling friction, but gives the co-efficient of the whole of the train resistances which may vary considerably from the preceding co-efficient : thus if we take one of the experiments detailed by Pambour, and calculate f by formula (1), we find it to be 5·90lbs. ; but if we calculate f' by formula (2), we find it to be 8·15lbs., showing a difference of 27 per cent. between friction proper and total resistance, to be attributed to the atmosphere. It seems to us on that account, that any experiments made in this manner (and it has been done of late by Mr. Dixon, of the Stockton and Darlington Railway), not with a view of ascertaining pure frictional resistance, but with the object of finding a co-efficient of train resistances, must be of very limited practical utility, for the results obtained can scarcely embody an average value of the atmospheric resistance, since it appears from the above calculation that even at the low speeds of from 12 to 18 miles per hour in calm weather, that resistance amounts to 27 per cent. of the whole. Pambour assumed, and later experiments have proved that friction is constant at all speeds, but he took no cognizance of any variable retarding causes save that of the atmosphere, and though he mentions that the condition of the rails will have some influence upon the value of the co-efficient of friction, he does not seem to have believed that the retarding effect of concussions arising from inequalities of the road would be very considerable.

Later writers however, who all agree with him in assuming a constant co-efficient of friction of 6lbs. per ton, have endeavoured to rectify the omission just mentioned—with what amount of success may perhaps be judged by a comparison of their respective opinons on the subject as embodied in the formula, constructed to give it a numerical expression ; thus Harding makes the co-efficient of resistance from concussion

$$R\,c = \frac{V}{3}$$

while Sewell makes it,

$$R\,c = \frac{V}{15}$$

V in both cases denotes the speed in miles per hour, and their respective values are in the ratio of 1 to 5 ; but as these formulæ are only the result of speculation upon a very slender data, rather than of direct experiment, this great divergence is not so much to be wondered at as the fact itself of their existence. Mr. D. K. Clark, like the authors already mentioned, admits the uniform co-efficient of friction of 6lbs., but owing to the want of materials to work from does not attempt to detail the variable resistances ; he assumes them to increase as the square of the speed, and his formula for the co-efficient of all the train resistances stands thus

$$R\,t = 6 + \frac{V^2}{240}$$

V again denoting the speed in miles per hour. As it is a well established fact that the atmospheric resistance varies as the square of the speed, this formula has some good argument for itself especially when it is remembered that this latter forms the greater part of the variable resistances. Nothing, however, in theoretical mechanics warrants the assertion made by Mr. Clark, that the retarding effect of concussions and vibrations varies as the square of the speed, for, since the product of pressure by speed expresses mechanical work, if pressure, in the consummation of certain periods of impulse, varies as the square of the speed, then must the mechanical work absorbed or given up during that period be proportional to the square of that speed ; but, turning to the tables of experiments from which Mr. Clark has deduced his formula, we find as many instances nearly where his rule does not hold good, as cases where it does apply. Thus we find a train moving at the rate of about 22 miles, whose variable resistances are 3·28lbs. per ton, and a train moving at the rate of about 44 miles whose variable resistances are 8·48lbs., whereas by the above rule they ought to be 13lbs. ; with another train moving at 21 miles they are 2·43lbs., and moving at 42 miles they are 7·8lbs., whereas, by the rule they should be 9·81lbs. ; with another train moving at 13 miles the variable resistances are 2·09lbs. and moving at 26 miles they are 3·43lbs., whereas, by the rule they ought to be 8·4 ; such examples might be greatly multiplied, but these, we think, will suffice to show that Mr. Clark's formula is still open to considerable amendment.

The next point to investigate is that of the frictional resistance of the engine and tender itself, as being nearest akin to the subject we have just dealt with, and it will be readily perceived that in the case of the engine this resistance is of two kinds, namely, that due to the carriage and that due to the working parts of the steam engine proper.

Pambour ascertained the sum of these resistances first by means of the dynamometer, and then by means of the steam pressure upon the piston, taken at the moment when it was just sufficient to set the engine in motion; and assuming the resistance of the carriage to be 7lbs. per ton,—rather a little more than for common waggons, because the axle friction is greater,—the resistance of the working parts of the steam engine were found to be 7lbs. also : now, it is evident that this resistance must vary with the load to be drawn along, and this additional friction he found to be from 0·82lbs. to 1·39lbs. per ton of train, according as the engines were either without or with coupled driving wheels ; and the total resistance of the engine, therefore, according to him, would read as follows :—

$$R\,e = w\,.\,14 + W \begin{cases} 0{\cdot}82 \text{ for non-coupled engines.} \\ 1{\cdot}39 \text{ for coupled engines.} \end{cases}$$

where w expresses the weight of the engine, and W that of the train in tons. As regards the resistance of the tender he has assumed it, very properly we think, to be equal to that of an ordinary carriage, and therefore in his calculation of engine and train resistances it is to be considered as forming part of the train.

Mr. Sewell, in the work already mentioned, agrees with Pambour in making the engine resistances to consist of a constant quantity and of some variable ones, but widely differs from him in his opinion as to the nature of the elements which influence the former, as well as in his estimated amount of the former; for he assumes the constant resistance to be 5lbs per ton of engine and tender, the machinery friction due to their own weight to increase in the simple ratio of the speed, and that due to the weight of the train to increase in the ratio of the square of the speed, and his formula for the total engine and tender resistances reads thus:—

$$R\,e = w_1\,(5 + V \,.\, 0\cdot5 + V^2 \,.\, W \,.\, 0\cdot00004)$$

where w_1 stands for the weight of the engine and tender, and W for that of the train. This attempt at embodying a fact into a general formula admits of no remarks on our part, save that it is a matter of astonishment to us how such an egregious blunder could have found its way into print, for it must be evident to the most untutored mind in mechanical science that if the machinery friction arising from one portion of the load varies as the square of the speed, the friction due to the other portion must vary in the same ratio. Clark, who keeps closer to the track of Pambour, makes the constant resistance of engine and tender, as carriages, to be 6lbs. per ton, and the machinery friction due to engine, tender, and train, to be 2lbs. per ton, and, so far, agrees in principle with his learned predecessor, the difference in amount being chiefly due, no doubt, to the more perfect means for observation possessed by Mr. Clark than Pambour had at his disposal some fourteen years ago, as well as to the changes undergone by the working parts of the engine. But as it has been shown already that Pambour has under-estimated the variable resistances of the train, and as these must have an influence similar and proportional to that of the constant resistances, as a natural sequence also has he omitted this element of resistance of the working parts of the engine. Mr. Clark, however, has made provision for it in his formula for the total engine and tender resistances, which reads as follows:—

$$R\,e = 6\,w_1 \left(2 + \frac{v^2}{600}\right)(W + w_1)$$

where w_1 stands for the weight of engine and tender, W for that of the train, v for the speed in miles per hour, and in which the variable machinery friction is taken at about one-third that of the variable train resistance, that being the ratio of machinery friction due to the constant train resistances. It should be observed here, that although Mr.Clarke has undoubtedly handled this portion of the subject in a very able manner, yet must the objections raised against the validity of the law according to which the variable train resistances are supposed to increase, apply here of necessity also.

Introducing now the resistance due to gravity when the train ascends a gradient, and which is represented in lbs. per ton weight by the formula

$$R\,g = 2240\,\frac{h}{l}$$

where $\frac{h}{l}$ is the ratio of the incline, the sum of all the resistances to be overcome by the engine (back pressure excepted), would be thus expressed in lbs. per ton of engine tender and train.

By Pambour,

$$R = \frac{(1\cdot39 + 6)\,W + 0\cdot002687\,v^2\,(70 + 10\,n) + w\cdot14}{W + w} + 2240\,\frac{h}{l}$$

By Sewell,

$$R = \frac{w_1\,(5 + v\,0\cdot5 + v^2\,W\,0\cdot00004) + v^2\,B.\,0\cdot00002 + \frac{v\,W}{15} + W.\,6}{W + w_1} + 2240\,\frac{h}{l}$$

By Clark,

$$R = 6 + \frac{v^2}{240} + 2 + \frac{v^2}{600} + 2240\,\frac{h}{l} = 8 + \frac{v^2}{171}\,2240\,\frac{h}{l}$$

In the summation of these resistances, Pambour, and we ourselves are are inclined to think as a matter of course, that Mr. Sewell and Mr. Clark, have made the singular mistake not to allow for the additional machinery friction which necessarily must arise from the extra load due to gravity, and the amount of which should be one-third of that load; this defect, however, has been discovered and remedied by Dr. Rankine in his recent work on *Civil Engineering*, where he gives the value of R, or in other words, the co-efficient of resistances, as follows:—

$$R = 8 + \frac{v^2}{180} + 2240\,.\,\frac{4}{3}\,.\,\frac{h}{l}$$

and where the divider 180 is substituted for the divider 171, because he makes the variable machinery friction equal exactly to one-third the variable train resistances.

We do not know how far Dr. Rankine has investigated this question of train resistances, which, it must be perceived from the foregoing analysis remains yet in a very unsatisfactory state, but we are inclined to think that he only furnished his readers with the best data at his disposal, and on that ground we would venture to suggest to him, and through him to the British Association, that here is a subject for inquiry, certainly of the greatest practical importance and of very considerable abstract interest, and we earnestly hope, both for the interest of the public and for the credit of the profession, that our suggestion will not be allowed to pass unheeded.

To complete our analysis of the resistances which the engine has to overcome, we have now to inquire into the question of back pressure. Pambour endeavours to demonstrate by a very ingenious and very plausible argument, that it should increase in the simple ratio of the speed, in the ratio of the evaporative power of the boiler, and inversely as the area of the blast pipe; it seems rational, indeed, to suppose that this pressure should increase with the volume of steam to be discharged in a given time, and it seems rational also to admit that it should not follow the same law exactly as in the case of a body moving in an indefinite fluid at rest or nearly so, for here on the one hand the steam actually runs away from the piston, while at the same time the speed of the piston can never increase, without at the same time the pressure of the steam diminishing. Assuming the evaporative power per square foot of heating surface to be 0·2 cubic feet per hour, as it was found to be the case in his experiments on the subject, Pambour's formula for the back pressure reads thus:—

$$p = 0\cdot00226\,v\,\frac{A}{a}$$

where p, is the pressure on the square inch, v the speed of the engine in miles per hour, A the heating surface and a the area of the blast orifice, and the pressures given by the formula, as compared with those observed by direct experiment, agree as nearly as could be expected. His tables, however, give only a maximum loss of about 10 per cent of the mean pressure, whereas, Mr. Sewell says that it may be estimated at 27 per cent. of the whole resistances to be overcome, and from Mr. Gooch's experiments it appears that it may vary from about 5 per cent. to 35 per cent. of the mean pressure; this, we think, is conclusive proof that there is something wanting in Pambour's formula, and the defect does not seem to lie simply in the numerical co-efficient, for admitting it to be proportional to the pressure, Mr. Gooch's experiments show that it increases in a ratio nearer that of the square of the speed in the long periods of admission, a condition to which all the engines upon which Pambour operated were subject. Mr. Sewell also has concocted a formula purporting to define the intensity of the back pressure, but in doing so de seems to us to have been more unfortunate still than in any of his productions already quoted; his formula reads thus:—

$$p = (P^2 + V)\,.\,r\,0\cdot00001$$

where p again is the pressure per square inch, P the mean pressure in the cylinder, V the speed of the piston in feet per minute and r the ratio of the area of the blast pipe to the capacity of the cylinder. To assert that the back pressure, or the reaction of the steam as it leaves the cylinder is proportional to the square of its mean pressure is bad enough, but to assert that it varies as the sum of the square of pressure and speed is evidence of a want of correct knowledge of the first principles of mechanics, not to be looked for in a person who undertakes to edit the venerable works of Tredgold. Mr. Clark does not undertake to define the back pressure, though he inclines to the belief that it varies in the ratio of the square of the speed of piston, but from Mr. Gooch's experiments he has constructed a formula defining the mean effective pressure at various grades of expansion, in per centage of the maximum pressure of steam in the cylinder; his formula runs thus:—

$$P\,e = 13\cdot5\,\sqrt{a} - 28$$

where P e represents the percentage of pressure, a the percentage of admission of the stroke, and in which the back pressure is assumed to represent 28 per cent. of maximum pressure in the cylinder. This certainly is a convenient way of disposing of the matter, and yet endeavouring to satisfy a practical want, but looking at it from an abstract point of view it still leaves the question unsettled. What law does the pressure of the steam on the back of the piston follow, and what is the amount? It would be presumptuous in us to attempt supplying this deficiency, for the experiments on record are too few to warrant such an undertaking, but from a careful examination of Mr. Gooch's experiments, which also show that in the short periods of admission the back pressure varies only in the single ratio of the speed, we think that Pambour's formula might be made to give results as near the truth as empirical formulæ can be expected to do, by attaching to the factor v an exponent subject to vary, in some ratio, with the length of the period of admission. Upon this point, again, we are desirous to call the attention of the readers in mechanical science, who ought not to allow books to be written, and formulæ to be concocted in disregard of the well established principles of that science.

As regards Mr. Clarke's formula for the effective mean pressure we may, in the first place, remark that its practical utility must, under any circumstances, be very limited, for the pressure which we are in the first instance acquainted with is that of the steam in the boiler, and his formula does not contain the element of loss of pressure, sustained by the steam in its passage from the boiler to to the cylinder; in order, therefore, to its being of any use at all, we must first ascertain the maximum pressure by means of the indicator, and, after having done this, we require no formula to define the mean pressure, since we can get it by actual measurement from the diagram. On the other hand, and although we observe that it gives tolerably accurate results, as compared with a few of the slender data upon which it is based, we should like to know why it should vary rather in the ratio of the square root of the period of admission than in any other ratio, and when we have pointed out to Mr. Clark how utterly false are its results in the case of the extreme limits of long admission, we feel pretty certain that he will expunge it in a next edition of his work. The formula, it will be perceived, is composed of two parts, the one constant for back pressure and the other variable for the actual mean pressure; now this latter pressure could never, by any chance, exceed 100 per cent. of the maximum pressure, nor could any effective mean pressure exceed $100 - 28 = 72$ per cent. of that maximum pressure, yet when the calculation is made for the period of admission of 90 per cent. of the stroke, the mean actual pressure reaches the fabulous amount of 128·2 per cent. of the maximum pressure, and the mean effective pressure that of 100·2 per cent. of the same; for a period of 80 per cent. of the stroke the mean effective pressure would be 92 per cent. of the maximum pressure, and for a period of 75 per cent. it would be 89 per cent. of the maximum pressure. Strange to say, however, Mr. Clark has gravely, and we suppose in good faith, written this latter result into the columns of his table of effective pressures.

(*To be continued*).

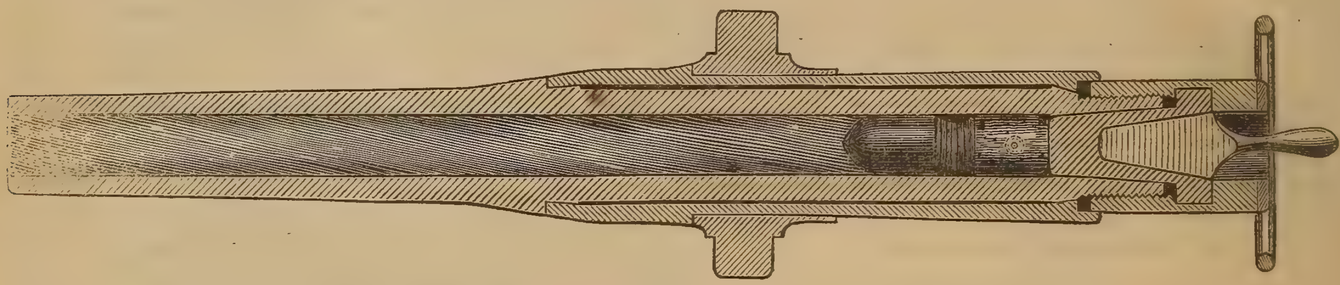


FIG. 1.

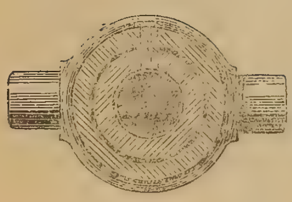


FIG. 2.

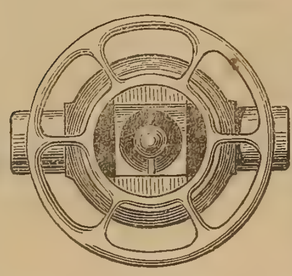


FIG. 3.

FIG. 4.

IMPROVEMENTS IN THE MANUFACTURE OF ORDNANCE.

BY H. TEMPLE HUMPHREYS.

The manufacture of the Armstrong gun, admirable as it may be, is still undoubtedly a most expensive process, and it is impossible, when critically examining one of these weapons, not to be struck with the amount of finish and skilled workmanship which is required to be elaborated upon each gun before it is finally turned out as fit for actual service. Additional to the expense of the "coil" system are the jackets (or, as in some modes of manufacture, a large number of rings), which have to be bored, turned, and fitted with the utmost nicety, in order that the proper amount of tension may be thrown upon every part of the breech when the jackets or rings contract in cooling. These conditions must always render this an expensive process, more especially as each of these operations requires the application of highly-skilled, and, consequently, costly labour.

It is unnecessary to enter more into the detail of the present mode of manufacture adopted by our Government, but it will suffice simply to point out the essential differences between the construction about to be considered and that of the Armstrong system.

The whole principle of the proposed system may be concisely described in the following manner:—A certain number of tubes, of any convenient thickness, say $\frac{3}{4}$ plate, are superimposed concentrically upon the breech of any *ordinarily* constructed gun; their ends are "jumped up" in order to form fitting strips upon which they are shrunk, the one upon the other and on the gun,—leaving a very thin cylindrical annular space between each. Into these spaces molten lead, or a harder alloy, is injected by hydrostatic pressure, and any required strain or spring exerted *inter se* and on the gun, by increasing the pressure arithmetically in each space, for instance, as in Fig. 4, illustrative of the principle applied to strengthening a hydrostatic press cylinder. Take the pressure of the atmosphere as *nil*, that in the first or outermost annular space at 1 ton per square inch, the second at 2 tons per square inch, in the third 3 tons per square inch, in the fourth 4 tons per square inch, and so on untll the cast iron core itself is pressed with a sufficient external force or *spring* of the tubes to resist, with the strength of the cast iron core itself, the required internal bursting strain. The molten metal is then cooled under pressure, and thus each tube, whilst bearing only its own safety strain (say, 1 ton per square inch, which is the difference or arithmetical ratio of the above series), contributes its quota, and is summed up upon the breech, and there, collectively with the others, exerts its spring or external crushing force before the internal strain takes place.

These improvements are intended to effect in one operation, and with ordinary appliances, what is done in other processes by shrinking jackets or rings around an expensively constructed breech; and moreover on the improved method, that objectionable uncertainty as to the exact amount of strain the shrunken rings have exerted could never occur, as the whole process is completed by hydrostatic pressure, which is perfectly determinable and can be regulated to any required extent.

In Figs. 1, 2, and 3, only one tube or jacket is shown, as it is imagined that guns of that calibre would require but that number. It is in the large guns, for smashing as well as perforating armour-plates where the full advantage of this system will be derived.

The mode of stopping the breech demands no explanation, as it is simply an alternative design to the objectionable plan of piercing the side of the breech for admission of the breech-piece, and also to avoid any edges or corners either in the gun or stopper, which can be damaged by the tremendous initial heat and force of explosion.

The most striking advantages claimed for this system may be briefly described as follows:—

1st. Lightness. As *every layer* is called into action, and from the nature of plate, a greater per centage of strength may be calculated upon than if the same amount of metal were solid.

2nd. Economy. As no expensive or extraordinary manufacture is required for the gun itself, and from the fact that the tubes simply require to be bored and turned on their jumped ends only.

3rd. A certainty of result, as the superimposed strains can be regulated with the utmost nicety, and the possiblity of flaws or of unequal and partial shrinkage avoided.

The principle can easily be applied to the cast iron service guns already in existence, and from its simplicity it is an admirable and economical substitute for the expensive and uncertain built-up process.

Arrangements have, we understand, been made whereby these guns can be manufactured at a price 20 per cent. less per diameter of bore, than by any other mode of construction.

For hydrostatic press cylinders, a saving is effected of at least half the weight per diameter of plunger, than if constructed entirely of cast iron.

ARMOUR PLATES AND PROJECTILES.

From the experiments made by Mr. Whitworth against the *Warrior* target at Shoeburyness, we think it may be conceded as an established fact that the flat headed projectile will penetrate any iron plates hitherto in use, although it appears that the hole produced is not satisfactory, as it can be easily plugged. We would call attention to a peculiarly formed projectile which has been brought under our notice by Mr. R. Crozier. It is a flat headed projectile with a flat headed circular punch, half the diameter of the head of the projectile, and say about the length of the thickness of the iron to be penetrated. From the concluding paragraph of the *Times*' account of the experiments at Shoeburyness, it would appear that Mr. Whitworth is about to adopt something similar to this description of projectile, though if we understand the report correctly, we fear it is a spherical headed punch which we deem to be an unnecessary abandonment of the success of the flat headed missile. Although we are of opinion that Mr. Crozier's proposed punch would certainly break off, we do not anticipate failure on that point, as the punch will always be too large in proportion to the projectile to fail in that particular; and a few experiments will soon determine what length will be sufficient, and how much smaller the punch can be made than the projectile itself. The principle sought to be established by Mr. Crozier, is a combination of the penetrating flat head with the bluff or round headed projectile, so that we may obtain the penetrating of the flat head with the fracturing effect of the round head. Mr. Crozier has been induced to adopt this form and to make some imperfect trials with the projectile, from the facts that in the earlier experiments against plates they were always fractured from the bolt holes (much ingenuity is being exercised at the present time to fix plates that shall not possess such defects), it may therefore be concluded that if a hole larger than a bolt hole could be produced by the projectile itself, it would be a step towards the desired object of fracturing the armour plates.

If the foregoing remarks carry with them any weight, we think, it may be argued that the adaptation of a punch to Sir W. Armstrong's round headed projectile will attain the desired object. Mr. Crozier prefers to employ a bluff headed projectile, formed with the punch in a slight concave with rounded outer edges; as that shape will not detract from the weight of the head so much as the spherical, and if the projectile can be thrown without rotary motion, a hexagonal punch might be employed. With regard to shells, it is suggested that if the punch can be made detached from the main projectile, it may form a shell and take its onward course and leave the main body to do whatever damage its form, or velocity, may be capable of effecting.

With regard to the teak backing to the iron-plates, from which much resistance is expected, it may be considered as mere fuel for shells to disport in and causing suffocation to the crew and destruction to the vessel, and, indeed, rather to facilitate the action of a punch than to offer resistance. The strong backing might be of some use against the spherical projectile; for its form is, we believe, the worst for penetrating iron, its action tending to bend it only, and the strong backing counteracting that.

LAMBETH SUSPENSION BRIDGE.

The new Suspension Bridge at Lambeth was thrown open to the public on the 10th ult. This bridge has been called for to meet a long denied, but at last acknowledged want—a want which is leading to the formation of metropolitan and underground railways in all directions—a want so imperative that it largely remunerates private enterprise for carrying out any scheme which renders this city more manageable in its great size, and more free in its lines of communication between the now widely distant districts. With this real demand came, of course, the supply, and a company composed of a small body of noblemen and gentlemen was formed to carry out the long-promised bridge at Lambeth at their own expense, and trusting to its usefulness to the public as shown by the daily tolls to reimburse them in their outlay. For once in the history of bridge building over the Thames no opposition was offered to the project. Mr. Barlow, the engineer, undertook that the structure from shore to shore should be completed for £30,000. This estimate for a foot and carriage traffic bridge across the Thames was regarded at the time as almost ridiculous. The cheapest bridge ever built across the river had not cost less than £3 per superficial foot—the majority have cost nearly £10—but here was an offer to build one at less than a pound a foot, and the engineering world were justified by all rule and precedent in being incredulous; however, this most moderate sum has not been very considerably exceeded. It is not a very handsome structure, but it is a very cheap and a very strong one, and above all, it is a bridge where a bridge was very much needed.

Lambeth New Suspension Bridge, has a total length over all of 1040 feet, and a length between the abutments on the shore at either side of 828 feet. Its extreme width is 32 feet, which is divided into 20 feet for roadway and six feet for each of the footpaths, and its total height above high-water mark is 21 feet clear. The rise or curve of the structure is one in 22 feet on the bridge itself, and one in 20 feet on the approaches. For such a steep rise the bridge itself should have given a greater headway than 21 feet, but this would have involved heavy outlay in raising the approaches at either end, and, of course, could not be attempted in a structure the total cost of all connected with which, even to painting and roads to it, was not to exceed £40,000. The suspension ropes are taken over four pairs of towers, two of which at either end rest on the abutments of solid masonry, and two are upon circular piers in the bed of the river. Over these towers the suspension ropes are carried, sustaining the bridge beneath in three spans of 280 feet in length each. These towers, though they look exceedingly light, are reported to be as many as seven times stronger than any strain they can ever be called upon to bear, even supposing the road and footway of the structure to be densely packed with a crowd of people. Each tower is of boiler plate $\frac{1}{4}$in. thick, strengthened with $2\frac{1}{2}$in. angle iron, and built upon the cellular principle adopted in the Britannia Bridge and in the double sides of the Great Eastern. The sectional area of these towers gives 120 square inches of iron, and the utmost weight which can come upon them, when the bridge is fully weighted to its load strain is only $2\frac{1}{2}$ tons per inch,—just half the strain which the Britannia Bridge, on the same principle, has always to carry, and, we believe, about one-third of the strain upon the great Victoria bridge at Montreal. At the abutments, as we have said, two of these towers rest on masonry of the most solid description. On the river piers they are fixed on circular cast iron cylinders, which are taken down 18 feet below the bed of the river and into the London clay. These cylinders are 12 feet diameter and $1\frac{1}{2}$ inches thick, and the mode of fixing them was, though on a very small and easy scale, much the same as that pursued wtih the very difficult foundations of the piers of Mr. Brunel's great bridge at Saltash. The cylinders were lowered into the places they were to occupy and forced down below the bed of the river. The water and mud were then dredged out, and the cylinder filled to a depth of nine feet with solid concrete, then three feet of solid brickwork, finishing with a brick invert arch, and thence a lining of three feet of solid brickwork up to the top of the cylinder on which the tower rests. This lining of brickwork, therefore, leaves a circular opening six feet wide in the cylinder down to the bed of the river, so that the work can be examined, if necessary, to its very foundations from time to time.

The ropes by which the bridge proper is suspended are of the best charcoal iron wire, and were made by Newall and Co. on the works of the bridge itself. There are two of these main ropes on each side, each being made up of seven massive ropes banded together, and each of these seven ropes containing seven strands of wire, two-tenths of an inch in diameter. The sectional area of each main rope is 100 square inches, and their united strength is guaranteed to bear a strain of 4000 tons, and in detail has been proved to that amount, though the greatest strain that can come upon the bridge is only estimated at 600 tons with ordinary traffic. These ropes are secured at either end round what may be termed a massive eye-bolt, with 28 screw-bolt fastenings, each fastening having already been tested with a strain of 82 tons. The "anchorage" in which all are finally secured on both sides of the river is on the Lambeth shore, where the ground is good, formed by massive iron holdfasts or beams, built into a solid masonry of concrete 20 feet below the surface. On the Westminster side, where the ground is little better than loose peat, the anchorage is made by a series of 12 square cast-iron caissons, each weighing seven tons, sunk into the gravel, and filled with concrete, and the square space thus enclosed by the whole twelve dug out and filled with concrete, so as to form one immense compact bed of iron and concrete 20 feet below the surface. Thus far, therefore, the ends of the ropes are as firmly secured as if they were taken down to the centre of gravity itself. It remains to be seen how, in this situation, the wire will resist the attacks of its great destroyer, rust. The want of efficient precautions against this apparently insignificant item of wear and tear has brought many wire-rope bridges to a premature end. From the wire ropes so secured come down a regular series of lattice tie rod uprights, with diagonal bracings on each side, at an angle from the roadway of 45 degrees. Beyond that these latter are placed closer than usual, and of greater strength, there is not much that differs in principle from other suspension bridges. The roadway in suspension bridges is usually hung to the ropes and tie rods, and there is an end of the work. In Mr. Barlow's bridge, however, a new principle is introduced, which almost, if not quite, does away with the lateral and vertical motion so dangerous to ordinary suspension bridges, and which has rendered some in this country, and many in America almost useless for heavy traffic. This consists of taking under the floor of the bridge what may be called two powerful longitudinal box girders, one on each side. The sectional area of each of these is 40 inches, and each is 2 feet 3 inches deep by 18 inches wide. These diminish any upward or downward movement to a *minimum*, and absolutely check all lateral swing. To these girders, which are, in fact, the backbone of the whole structure, the lattice tie rods we have described are fastened, and thus such rigidity is given that, calculating according to the strain wrought-iron ought to bear per inch, it is said that the whole floor of the bridge, if laid sideways, would even then be strong enough for its traffic.

Between these main box girders, which run from end to end of the whole structure, wrought-iron cross girders are laid at intervals of four feet apart. On these again are wrought-iron plates for the roadway, which is paved with a wooden pavement, set in mineral pitch, so as to give elasticity to the thoroughfare, while securing the ironwork beneath it from the action of either air or water. The footways on each side have a width of six feet, though they certainly do not seem to have even this narrow limit. After the spacious sidewalks of new Westminster, these appear like mere alleys by comparison. These footpaths on each side are carried on cantilevers or iron brackets projecting from beneath the roadway. Everything being made to do some duty in the strength of this singular bridge, the parapets of the footways are formed of wrought-iron lattice work, which in itself gives a support and rigidity to the otherwise light path. The paving of the footways is of Portland stone from old Westminster Bridge, cut in thin neat slabs. In the ornamental scrollwork of the brackets which carry them, the mains of the Lambeth Gas Company, 18 inches in diameter, cross the river, one under each side of the bridge. From the river these have a rather ornamental moulding appearance,—a matter in which the whole structure is, to say the least, deficient.

IMPORTANT EXPERIMENTS AT SHOEBURYNESS.

In order that the result of the proceedings which took place on the 13th ult. may be clearly understood, it is necessary to explain that the targets, which are built to the same strength as the broadsides of the armour frigates, have hitherto never been *pierced*, except on the recent trials with Mr. Whitworth's guns and flat-headed projectiles. A long-continued concentrated fire of Armstrong guns, or the more damaging solid shot thrown by the old smooth-bore 68 pounders, have bent and broken plates, but have never gone through them, or even done such mischief as would in any way seriously affect the strength or safety of a seagoing frigate. On his first recent trial Mr. Whitworth, succeeded in sending his flat-fronted shot completely through one of these targets at 200 yards' range. His second trial, was made with a 120 pounder, which had been manufactured at Woolwich, after the plan used by Sir William Armstrong—a series of iron coils welded together and shrunk on, one over the other. With this piece rifled on the Whitworth principle, but loading at the muzzle, not only was a solid shot sent through a Warrior target at 400 yards, but a shell also, which burst inside the armour plate, and lit the solid timber framework of the backing. This penetration of the shell was considered to be the most wonderful success of all.

To make the shell as solid as possible Mr. Whitworth did not leave enough room for his bursting charge, so that the additional mischief caused by the explosion of the missile was not of much account. Artillerists also wished, before admitting the enormous powers of the gun, to try its penetration against the iron targets at 1000 yards—a range of such length as would set this merit of the ordnance beyond all possibillty of doubt or question if it was able at that distance to penetrate its mark. The trials on this occasion then were to set at rest these two important questions—first, to show if without dimishing the penetrating force of the shell it could be made to contain so much powder as to make its explosion terrible; secondly, if at a much longer range the gun with solid shot could do as much mischief as it had done at 400 yards. The 70-pounder was also to be tried at 600 yards against the target.

The target used on the last occasion was not of the same strength in point of quality of material as the old Warrior target which stood so much battering. The iron was comparatively inferior, and remarkably hard and brittle. These defects, however, the supporters of Mr. Whitworth's gun claim as so many additional difficulties overcome, inasmuch as the hardened flat projectiles which cut their path easily through soft iron are liable to be broken on their way through a material somewhat similar in hardness to their own. The target fired at on this occasion was an entirely new one, about 10 feet high by some 14 or 15 feet broad. It was composed of three solid iron armour-plates, without break or porthole in any of them, and fastened to the timber backing with two inch bolts let in at the edges, so as not to have the same source of weakness as has been heretofore occasioned by taking them through the centre of the plates. The two lower plates were five inches thick (within half an inch of the thickness of the plates with which the new iron frigates now building are to be coated) and the upper plate was 4½ inches, the thickness of the Warrior's armour. The plates were made at the works of Messrs. Brown, Sheffield. These plates were lined with a teak backing of transverse timbers of 12in. and 6in. thick respectively and an inner skin of wrought iron plate, ⅝ of an inch thick. The sides and top were also enclosed, so as to make what is termed a box target, like the between decks of a ship, in order that the explosive effects of the shell, if it got inside, might be fully seen.

The 70-pounder was placed at a distance of 600 yards; the 120-pounder at 800. The latter it was wished to fix at 1000 yards, but this would have required the gun to be placed in a proximity supposed to be dangerous.

The experiments were begun with the 120-pounder, and nearly an hour was expended in trial shots at a wooden target to lay the gun properly for range. The first shell was fired, with a charge in the gun of 27lbs. of powder. This projectile weighed 151lbs., and contained a bursting charge of 5lbs. of powder. The initial velocity or rate of speed at which it left the muzzle of the gun was nearly 1500 feet per second, and it struck with a crash full upon the centre of a five-inch plate, at the rate of 1220 feet per second. As soon as the stifling smoke allowed an examination of the interior of the target, it was seen that the shell had passed completely through the plate, the 18 inches of teak backing, and inner skin of iron, bursting *inside*. The bursting, however, seemed to have taken place too soon and while the shell was still in the armour-plate, as the base or heel of the shell was fired out backwards and fell in front of the target, while the fragments that penetrated through appeared to have been deprived of their force, and fell almost harmless. The surrounding timbers inside certainly bore no signs of damage worth speaking of. Nothing in short, to show that the plates had not been penetrated with a solid projectile. The hole also in plate and timber was remarkably neat and clean cut, taking the form of the octagonal rifling, and having only an extreme width of 8 inches diameter—a kind of hole that could be plugged from the outside in a few minutes with very little trouble.

The second shot was also of 151lb. weight, loaded with the same bursting charge, and fired with the same charge of powder from the gun. This struck the middle plate of five inches thick on its upper edge, and, like the former, passed through all opposed to it and again burst inside. This time it exploded apparently when quite through the plate, shattering the teak backing to a slight extent, but doing a little more mischief with the fragments which had in one or two cases evidently struck the timber composing the box roof and sides of the target with more force. Still, however, there was the same comparative absence of shattering effect, and still there was the same clean hole as easily plugged as the first. The third trial was with a cast iron hollow flat-headed shot weighing 130lb., and without any bursting charge. This was fired to show the immense superiority of Mr. Whitworth's steel projectiles over the cast shot and bolts hitherto used in trials with Armstrong and other guns against armour-plates. The result of this experiment was conclusive. The shot, instead of penetrating the plate, broke in fragments against it, only inflicting a dint of some two inches deep; no more mischief, in fact, than is done with the Armstrong 100-pounder, and for very much the same reason—that the cast iron shot once broken up instantly loses in its pieces the force it possessed when striking as a whole mass. The fourth trial was made with a 130-pounder steel shell loaded with only 3¾ lb. of powder, and fired from the same gun at the usual range and 27 lb charge This did no less than the former shells had done, going through all and bursting inside, but it also did no more, either in its explosive force or in the nature of the hole it pierced. The fifth and last experiment made with the 120-pounder was with a solid steel shot of 130 lb. weight, which also went through the target and fell inside the box, if we may so term it.

The trial was then continued with the 70-pounder at 600 yards. This experiment was looked to with much interest, as the 70-pounder, weighing less than 4 tons, is eminently adapted for use on shipboard if its penetrative power can be made equal to the work of piercing iron frigates with effect. The first trial proved that in this respect, even at 600 yards, it could do almost as much as the 120-pounder as far as penetration is concerned. The gun was fired with a 13lb. charge, the shell weighing 81lbs. having a bursting charge of 3lbs. 12ozs. of powder. This struck the uppermost or *Warrior* plate of 4½ inches, but having of course the same backing as the other parts of the target, through all of which, but the inner skin, it passed, bursting in the wood which it splintered upward in a part near the edge of the target. This latter circumstance prevented the full explosion of the powder being shown. Another was, therefore, fired with better results, passing through the plate and doing very much more damage to the teak, but making no worse hole than those which had preceded it throughout the day, and the same with the third and last shot. To estimate the importance of this part of the experiment it must be remembered that other guns, smooth-bore and rifled, have fired in salvoes nearly as much as 900lbs. weight of shot in single discharges at 200 yards against similar plates without doing more than bending, or at most cracking them, but never penetrating them.

On the following day these experiments were resumed. The first attempts were made with the Armstrong 110-pounder, in order to obtain some results which Sir William desired. The gun was loaded with charges of powder varying at different times from 12lbs. to 16lbs., but always with the same kind of projectile—a conical 110lb. shot, cut short at the base, so as to reduce it to the weight of 68lbs. This at a range of 200 yards was fired at the target which Mr. Whitworth had so riddled the day previous. The shots were always directed upon uninjured portions of the 5-inch plates, and contrary to general expectation they inflicted not only a much deeper indentation than the common spherical 68lb. shot, but effected nearly double the amount of penetration usually made by the same kind of missile when fired at its full weight of 110lbs. In no case, however, did they penetrate the plate or crack it, or indent it deeper than four inches, and in every instance the point of the cone was broken off and the main body of metal behind the cone was shattered to fragments. The next trials were made against two targets, each about four feet square, placed side by side and covered with a wrought-iron armour plate one inch thick. One, however, had its plate backed with 18 inches of solid teak, the other with 18 inches of thin cardboard, or, rather, very thick brown paper leaves bound and pressed together as closely as possible. The first shots fired were with the small Armstrong 6-pounder, with the usual light service charge, at 100 yards' range. Each of these went through the iron plates, and that directed against the target with the wooden backing buried its whole length in the teak, and there remained. Into the paper backing, however, the shot barely entered two inches and then stopped dead. The 12-pounder was then fired with very different results. It penetrated the armour plates, and in turn passed entirely through the thickness of both targets. Through the paper one it made a loose, ragged, hole, through which it was easy to pass the hand for some little distance; but the teak backing, from the elasticity of the wood, closed so instantaneously after the passage of the shot, as to leave no mark beyond the first dint to show that a shot had struck it at all. The Whitworth 12-pounder was then tried against a target of iron plates 2½in. thick, and inclining backwards at an angle of 45 degrees—an angle at which no gun yet known but Whitworth's will send its shot through the plates. This trial afforded a curious proof of the value of Mr. Whitworth's hardened steel, as compared with cast iron projectiles. Two flat-headed shot, which it was supposed at the time were steel, were fired at the inclined target, but, to the astonishment of every one, they shattered on it, and, glancing upwards, sent their fragments into the air. A result thus utterly at variance with all previous experiments with the same gun against similar targets was so inexplicable, that an immediate inquiry was made, when it was found the Artillery sergeant had by mistake taken the cast iron projectiles, which Mr. Whitworth only uses to exemplify their worthlessness against plates. Two of the proper hardened steel shells were then fired, and did what they had never failed to do—went through the plate, though inclined upwards and backwards at such an acute angle, and giving a thickness of 3⅝in. at the point of penetration. The last of these two shots, though it broke through the plates, was broken to pieces itself, and its fragments, strange to say, fell all *in front* of the target. The charge used with these shot was only 1½lb. of powder.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

CAMBRIDGE MEETING, 1862.

ON A NEW MARINE BOILER.

INVENTED AND PATENTED BY DR. FILIPPO GRIMALDI.

The object of this paper was intended to draw the attention of the Section to a new kind of steam boiler, adapted both for stationary and marine purposes, but more particularly to point out its advantages in the latter case, and especially when employed for generating high pressure steam; or in iron-plated ships of war, where saving of weight and space are of the utmost importance.

The peculiarity of the arrangement referred to is that of making the boiler continually rotate on its axis, over the furnace while at work. This involves necessarily a complete change in the shape of the boiler, as also in the mode of feeding it, and in the arrangements for the exit of the steam.

The advantages of the arrangement, as regards rapid generation of steam, result from the fact that the water being an indifferent conductor of heat, this is disseminated almost entirely by a mechanical mixture of its particles, this mixture being very materially increased by the constant dipping and rising of the tubes which are dispersed throughout the boiler. Again it is well known that when steam is generated in contact with a heated surface, if that surface be stationary there is considerable difficulty in the steam freeing itself from such surface, this difficulty being, apparently, entirely removed by steadily moving the surface, so as to bring it successively under new portions of water; the surface being, as it were, swept of the globules of steam which have accumulated upon it.

In the rotating boiler this continual sweeping of the surfaces applies both to the shell of the boiler, and to the tubes, their rotation being very slow, while the water is practically stationary.

The rotating boiler necessarily assumes the cylindrical shape, no other form being so suitable. It is thus specially adapted for the generation of high pressure steam, and is, consequently, well worthy the attention of those who have for some years past been aiming at the construction of high pressure marine boilers, their efforts, however, appearing to have failed, chiefly from such boiler being made to assume a rectangular shape; the ordinary amount of heating surface, if attempted to be obtained in a common cylindrical tubular boiler, involving considerable space, which can be ill afforded in steam vessels.

Without attempting to fix what precise extent of revolving heating surface will, in practice, be found equivalent to that ordinarily allowed in marine boilers, it may be here stated that from the experience already had, about one-fifth the surface appears sufficient—9 square feet of *horizontal* surface, or 15ft. of total surface, being usually calculated as sufficient for evaporating a cubic foot of water per hour, and 2 square feet having done this with the boiler revolving. Of course this amount of surface in both cases supposes the surface clean; from 20 to 30 feet being frequently given to each horse-power in marine boilers as generally made. The rotating boiler (shewn in a diagram exhibited to the section), is cylindrical with flat ends, and nearly filled with 3in. tubes; trunnions are constructed at each end, through one of which the feed pipe passes, and through the other the steam pipe, which radiates from the centre to the circumference between the valves, the steam entering at the highest point of the boiler or nearly so, and thus taking no water with it; the upper tubes or those passing through the steam space most effectually superheating the steam and preventing priming. The safety valves of these boilers are fitted to the stationary steam pipe, and the steam and water gauges are conveniently arranged in the manner shown. The boiler is kept rotating at the rate of from 1¼ to 1½ revolutions per minute, by means of a suitable connection with the screw shaft or by a separate engine which may also serve as a donkey for feeding the boiler and other purposes.

The whole boiler is enclosed in a brick lined casing, or in a double iron casing filled with water, a few inches larger than the boiler, so as to give a flue space all round it. Every part of the shell of the boiler in its turn passes over the furnace, which is placed beneath it, the entire boiler being thus rendered available as heating surface. This it should be explained is one of the reasons why so small a boiler as the one experimented upon and found capable of generating so large a quantity of steam; for taking the efficiency of moving surface as only equal to double that of stationary surface, the entire shell of the boiler—top, bottom, sides, and ends—becomes heating surface, and that of the best kind, being brought horizontal, and immediately over the furnace, which is usually made to extend over the entire bottom of the boiler.

In this arrangement the plates of the boiler can never become overheated, as however small the quantity of water in the boiler, the bottom is certain to be just covered, thus rendering explosion from this cause almost impossible.

It appears that the rotation of the shell and tubes of a boiler greatly retards, if it does not entirely prevent, ordinary incrustation. The small experimental boiler at the Exhibition, after being at work with very indifferent water for fourteen months, was examined at about six months intervals, and found to be covered with a light dust on the inside, but to have no appearance of incrustation, although slight traces of this were found at those parts of the boiler which did not move, such as at the feed pipe, which is inside the boiler. The singular manner in which many marine boilers have been affected, apparently by the action of acid, in the greasy patches found on the sides of the boilers and on the tubes, where surface condensers are employed, has not yet been satisfactorily accounted for, but may partly be due to the scum floating on the water always being in contact with the same part of the boiler. It is more than probable that in the rotating boiler this evil will be entirely remedied, the whole surface of the shell being brought in contact with the scum, but for a very short time only, as regards any one part of it. Experience is, however, wanting on this point.

As regards the employment of this class of boiler for ships of war, and especially iron-plated ones, it possesses two important advantages, first its being a very low boiler, the largest size not exceeding 10ft. in height, and secondly its weight, with water and casing complete, not amounting to one half that of ordinary marine boilers, even allowing the same heating surface, which, as has been stated, will probably be found to be three or even four times more than necessary. Its size is also very greatly diminished as will be seen from the following particulars:—An ordinary marine boiler, having about 1400ft of effective heating surface, occupies a space of 10ft. 6in., by 11ft. 6in., and is 16ft. 6in. high, weighing, with water, 31½ tons. This gives 51 lbs. per square foot of heating surface, and the floor space occupied nearly equal to one-tenth of a square foot, also per square foot of heating surface.

On the other hand a revolving boiler, having upwards of 1600ft of heating surface, occupies a space of 9ft. 6in. by 7ft. 4in., and is 9ft. 7in. high, occupying thus only one-twentyfifth of a square foot of heating surface. weighing, with water, 13 tons, equal to 18 lbs, per square foot of heating surface.

Thus, assuming for the moment, that a square foot of heating surface is equally efficient both in the ordinary marine and the rotating boiler, it will be seen that the rotating one is less in every way, viz.:—

In weight about one-third.
In bulk about one-fourth.
In height about one-half.
In floor space about one-fourth.

With the revolving surface only doubly as effective as stationary surface, these advantages would be just doubled, and if experience in future justifies the conclusions already arrived at, one third of the above amounts would be the relative weight and spaces occupied respectively by a rotating boiler of equal power to a common boiler.

One word, in conclusion, as to consumption of fuel. On this point results of experience cannot be given, inasmuch as the boiler now at the Exhibition, is too small to lead to enable conclusions to be formed. It is 18in. in diameter only, and 18in. long, but it has converted into superheated steam 7½lbs of water by the consumption of 1lb. of coal. In larger boilers there can be no doubt that a good result will be obtained, owing first to the small quamtity of water contained in the boiler, and consequently to the rapidity with which the steam is raised, and secondly, owing to the steam being in contact with one half of the whole heating surface, and thus leaving the boiler highly superheated. The decrease in weight and size, and consequently diminished cost, freedom from excessive wear in any one or more of its parts, the wear being quite uniform, the strongest possible form, and freedom from liability to explosion from this cause, as also from uniformity of wear and tear; simplicity in manufacture and repairing; everthing seems to recommend this boiler as a most suitable high pressure one for steam vessels.

In order thoroughly to ascertain what advantages can actually be realised in practice, a boiler of 30 nominal horse-power is now being constructed by Mr. John Stewart, of Blackwall Iron Works, and which after being fully proved on land, will be piaced on board a vessel to be subjected to the ordinary usage of marine boilers.

INSTITUTE OF BRITISH ARCHITECTS.

THE PRESIDENT'S ADDRESS.

Gentlemen,—In obedience to what has now become our regular custom, it is my duty as your President to address you on this our first meeting for the session of 1862-63. And I have the more pleasure in doing so, because I think the Institute has never exhibited so satisfactory an appearance, whether we regard its influence in society and in the scientific world, the increasing number of its members, or the prosperous state of our funds.

Nothwithstanding, however, this satisfactory condition of our affairs, the events which I shall have to bring under your consideration must be prefaced by a notice of the melancholy bereavement the nation generally, and the Institute of Architects particularly, have to deplore in the premature death of one of our distinguished patrons, in the person of the Prince Consort.

At the time that event happened, we offered to her Gracious Majesty the Queen our humble but affectionate condolence; but I must still be permitted to add a few words on this melancholy subject.

His Royal Highness the Prince Consort earned, in the course of his short but eminently useful career, the gratitude and esteem of all who are directly or indirectly connected with the development of a taste for the fine arts in our fatherland. It is not for us, feeling bitterly as we still do the loss of a kind patron, and an earnest lover of our profession, to inquire curiously into the peculiar tastes, or the æsthetical theories adopted by his late Royal Highness in matters connected with architecture; because, emphatically, these are questions beyond the reach of abstract reasoning, and because the manner of their solution depends greatly upon the early associations which modify the faculties to be brought into action in our perceptions of the good, the beautiful, and the true. We may, then, entertain individually opinions with regard to objects of art different from those which guided the late Prince in his preference for certain architectural forms; but after every allowance has been made on this score, the conviction must remain that his Royal Highness actually did more to promote the love of pure art, for art's sake, than any of his precessors in the positions which enable men to modify the modes of thought of their contemporaries. On occasions of the public expression of regret for the loss of one so good and great, it is, perhaps, undesirable to suggest comparisons of any description, because they are apt to disturb the unanimity of feeling it is so desirable to retain; but I cannot refrain from remarking that one of the characteristics of the action of his late Royal Highness in his patronage of art always seemed to me to be especially worthy of admiration; namely, his respect for personal character and independence of judgment on the part of those whom he delighted to honour. He loved art for art's sake; not for the sake of imposing his own views and opinions on its external manifestations. His loss has been indeed a heavy blow to English art in all its branches. Our estimation of the good he has done, and the best proof of our regret for his premature removal from amongst us, would be, I humbly think, most satisfactorily shown by our endeavouring to carry forward, so far as lies in our power, the task he set to himself, namely, that of improving the tone and of diffusing the love for art. So he laboured; and so shall we most effectually retain his spirit, and advance his work!

The next important event to which I propose to call your attention is the one the departed Prince had himself zealously laboured to prepare during his lifetime, and which will always be connected with his name in the nation's recollections; I mean the Great International Exhibition. Properly understood, and properly managed, these periodical gatherings of the product of art and manufacture from all quarters of the globe must be the most efficient means of advancing the attainment of that "peace on earth and goodwill toward men," which we believe to be the end of all social organisation; and though the bright visions men began to indulge upon the occasion of the inauguration of the first great gathering of this description have been rudely shaken by the sad events now taking place in America, it is still morally certain that the more nations learn to apperciate one another's merits and powers, the less likely are misunderstandings to arise amongst them.

As to the building erected for the purposes of this Exhibition, it will be most becoming for architects to observe silence on the subject of its artistic qualities; but we certainly may record our protest against its being in any wise considered as a representative of the architectural taste of our age and times. It was unfortunate that a gentleman whose studies and pursuits had not been of a nature to develope the artistic faculties required for the successful cultivation of our profession, should have been selected to design and execute a structure necessarily intended to illustrate before the assembled nations the actual state of art amongst Englishmen. The very merits of the construction do but point the moral of this objection, because they are of a nature to indicate that its author had solely directed his attention to the scientific and technical details of the problem submitted to him, without being able to grasp its æsthetical or moral signification. We thus find that the goods are exhibited in a shed, tolerably well lighted; the pictures and sculptures are also placed in rooms where they can be seen, speaking generally, in a very advantageous manner; indeed, the picture galleries are the most successful parts of the building; though I am disposed to to abate considerably from the reputation of originality and merit assigned to them by official crictics. But there is an absence of artistic treatment in the plan of the building; and to such an extent is this the case, that even the proper arrangement of the articles exposed has suffered from their bad distribution; whilst the general elevation and the ornamental details of the exterior particularly are very objectionable. No architect could have designed a work so unsatisfactory had he but studied the rudiments of his profession, and yet British architects are unhappily represented to assembled Europe by this eminently unarchitectural building! Even the Crystal Palace of 1851 could boast of merits superior to those of its successor, and it gave signs of the existences of a desire on the part of artists, and of the public, to seek some new mode of expressing the peculiar feelings and wants of the age. Compared with the Crystal Palace, the new International Exhibition building has been a step backwards rather than a step forwards in art development; and, as such, it cannot be regarded as a fair exponent of the effects notoriously produced upon our profession by the great intellectual movements of late years.

It is a matter of extreme pain to me thus to feel obliged to criticise the labours of men who have laboured earnestly in the discharge of their duties; but, as your President, it is necessary to place on record the fact that British architects are in no wise responsible for the International Exhibition building, and that they who would seek to trace the progress of architecture in England during the period 1851 and 1862 must turn to other quarters for the elements of comparison.

In my address of last year, I pointed out what I believed to be the position of our profession in society, and I illustrated it by incidents that had occurred in the House of Commons, and opinions expressed there and received even with applause, though little complimentary to our attainments, or our scientific position. I cannot venture to think that my humble appeal would do much towards our advancement; but at the same time one circumstance has occurred of so eminently satisfactory a character, that I am sure I shall be pardoned in this place for calling particular attention to it. You will at once perceive that I allude to the invitation made to some of us, *as architects*, to advise the very distinguished committee appointed by her Majesty on the subject of the intended memorial to the memory of the Prince Consort. This invitation also has this most flattering incident connected with it, that the suggestion came from her gracious Majesty herself. The advice we ventured to give has been, I am happy to say, approved by the distinguished men with whom we were placed in communication; it has given satisfaction in the highest quarters, and, notwithstanding some ungenerous and violently unjust individual criticism, has been well received by the public. I hope, and I believe, that our well-known and able colleagues, now anxiously engaged in the realisation of our suggestions, will achieve the success which the nation so anxiously desires.

With this gratifying fact before us, we may, I think, dismiss from our thoughts all further reference to the studied neglect of architects by the Governmental department connected with the art education of the country, and the absurd and laboured attack of one of the officers of that department, who seemed to have forgotten that such men as Inigo Jones and Wren, Chambers and Soane, or Smirke and Barry, had ever lived in England; or Michael Angelo, or Bramante, or Vignola, or Palladio, or a thousand others, had flourished in Italy; or that Perrault or Perronet, or Hittorff or Visconti had lived, or were living, in France; or that Kleuze or Schinkel had ever lived or flourished in Germany; or that he must have known architects in this country to whom his countrymen were not insensible as having some claims in the scientific world.

Before I pass from this subject, however, I cannot but express my hope that the profession I am attached to, and that I have followed for more than forty years, may receive from me in a kindly spirit a few words of caution, that we ought not to forget that the great principles of art demand something more than a mere patient reproduction of forms eliminated in, and appropriate to other times, without a sufficient reference to the great power given in us by new materials, demanding different treatment, and a new exertion of the imaginative faculty. I shall have occasion to say presently a word or two on the subject of art education amongst ourselves, and what the institute desires to do to promote it, for it is a subject of great interest, because in other countries—as, for instance, in France and Belgium—the State interferes actively to provide the means of art education for the mass of the nation, under such conditions as to allow almost every one, who may desire it, to acquire sound and comprehensive opinions upon art questions; and the gratuitous course of lectures, and the industrial and drawing schools, are so brought, as it were, to the doors of the people in general, that they have, in the two instances cited, actually be comes nations of artists. There are many grave reasons for hesitation on our parts before we adopt the system of State intervention in these details of education, and also for believing that no sound vital art can be produced by such a forcing process. But, nevertheless, the importance of addressing himself to a sypathising and educated public must be to the artist so great, that we may well consider how it would be possible for us, in our private capacity, to labour to diffuse more correct principles of taste than seem unfortunately now to prevail in our country. We need not seek to impose our own views, but we may strive to teach as well as to learn; but we must always bear in mind that we shall not be able to influence public opinion unless we are really and truly of our own times, and true exponents of the spirit and feelings of our age in all that is good and pure, without servile deference to fashion, or yielding in any way the rights of our own consciences to temporary popular fancies or errors; we ought in fact, to endeavour to guide the opinions of our contemporaries in the formation of their æsthetical principles, as applied to architecture, in the direction of devotion to moral beauty and earnest truthfulness.

Much has been done of late towards the attainment of the great object referred to, by the labours of our respected friends, Messrs. Sidney Smirke and Gilbert Scott, and by the authors of the papers read at your meeting; but the audiences addressed on these occasions are limited, and the publicity given to this teaching does not reach the majority of those whom it is so desirable to enlighten. It seems to me that one of the most powerful instruments for diffusing the knowledge we are so much interested in imparting, would be by establishing courses of lectures upon subjects connected with our art, written expressly in a popular and attractive style, and open, if not gratuitously, at least at a very low rate of payment, to all persons connected directly, or indirectly, wfth the building trades. The object we have to aim at is, as it were, to produce an atmosphere of art feeling, and this can only be obtained by popularising art, and by raising the tastes of all around us; and moreover, we, as architects, have a direct interest in advancing the art education of the classes who really carry out our designs, in order to ensure their being executed in the spirit with which they were conceived. It is precisely in the want of artistic feeling, and of true knowledge of the ends and object of their pursuits, that our artizans are inferior to those of the Continent; and it is our duty, I hold, to strive to remove this obstacle to our art progress, at the same time that we diffuse the taste for architecture amongst the general public, by placing within the reach of those who may wish to learn, the means of forming correct opinions on the subject. Of course it is difficult to organise any such system of public education, and to give it a permanent character; and the history of the mechanics' institutions proves that good intentions are not alone sufficient for the purpose; but a firm faith in the policy of any course of proceeding almost inevitably leads to the discovery of the means for attaining it. "Where there is a will, there is a way," and surely there can be no greater difficulty in organising some form of gratuitous art education at the present day, than there was formerly in organising the grammar schools, and the municipal corporations, to which many of the functions of educational boards upon technical matters were entrusted. Our own institution might do much to popularise the knowledge of architecture; and in this very building other societies periodically meet, which might render efficient service in the cause.

The discussion of the present and of the probable future state of English architectural education, would, I fear, lead me too far, were I to pursue it to its legitimate limits, and indeed I fear it has carried me somewhat beyond the space allowable in an inaugural discourse. Its vital importance to our profession must be my excuse, and most sincerely do I hope that the ideas I have expressed may induce more able heads than mine to ponder over its difficulties. At present, however, I return to the consideration of temporary events, and resume our cursory view of their nature and tendency.

On all sides we find that the fashion for municipal alterations set by our neighbours is being followed, with more or less enthusiasm; and the various technical journals prove that such towns as Brussels, the Hague, Berlin, Vienna, &c., are undergoing a species of transformation, though on a different scale, yet analagous to the one lately carried out in Paris. In London we have also entered upon the same course, and, under the guidance of the Metropolitan Board of Works, of the Corporation of London, and of the various railway companies, very great changes are in progress, or at least are in contemplation, under such conditions as to justify the belief that they will soon pass into the class of facts. The most important of the questions thus referred to is, unquestionably, the embankment of the north side of the Thames, and most earnestly do I hope that this work may be carried to its conclusion in such a manner as to add to the monumental character of our metropolis. Differences of opinion have occurred with respect to the manner and to the extent in which this work should be carried out; and, unfortunately, hard words have been bandied about by men who ought to have had better taste than to abuse those who happened to differ from them on matters of detail. The legislature has, however, passed a law which settles these disputes, and all parties must now labour to carry out successfully the measure so adopted; it is but a small instalment of what is required to be done to the Thames, in the interest of the navigation, quite as much as in the interest of the embellishment of the city. Unfortunately we, as a nation, priding ourselves as we do on our practical character, are indisposed to treat general subjects in a comprehensive manner; and thus it is to be feared that we shall continue to deal with the embankment of the Thames in the same piecemeal spirit which has produced the partial embankments at the Isle of Dogs, at the Houses of Parliament, and at Pimlico and Chelsea, whilst it opposes the establishment of stable conditions of the bed and of the currents of the river. It is a great thing, however, to have resolutely entered upon the embankment of the north side of the river, and to have sought there the means of partially relieving our overcrowded streets: time will compel the execution of the complete scheme.

And here it may be appropriate to notice the various new bridges erected over the river; because not only are they amongst the most striking monuments of the day, but also because they seem to me "to point the moral" of the inconvenience before referred to as resulting from the separation of the profession of architecture and of civil engineering. I do not propose to discuss the methods of construction adopted in these bridges, though much may be said on the subject; but as an architect I cannot refrain from the expression of regret that their designers had not studied more carefully the laws of optical effect, or the logical application of archæological forms. The parallel vertical cylinders and the parallel horizontal girders of the Hungerford bridge produce a combination of lines which must be declared to be very ugly; the street girder bridges are, if possible, worse. A study of Mr. Penrose's researches upon the Parthenon would have saved the author of the Hungerford bridge from the optical mistakes, if I may use that phrase, into which he has fallen; and a careful study of the effects produced by the various forms of elliptical arches, in combination with long *quasi* horizontal lines, would have taught the able engineer of Westminster bridge, that very flat ellipses under such circumstances always appear to deflect over the crown. For my own part, I may add, that it seems difficult to carry out, with any pretension to archæological correctness, a design for an iron bridge with flat elliptical arches in the later mediæval style, as practised in England; because the material employed is not susceptible of the deep splaying of the outline of the arches, which is the essential characteristic of all good mediæval arched work. The style adopted in the new Westminster bridge is, in fact, a mistake, into which a properly educated architect could not have fallen, and the great engineering merits of the work must render our regret for this artistic defect the more poignant; for, on the whole, this bridge is one of the noblest monuments on the Thames. The bridge leading to the Victoria Station is, as a work of art, in my opinion more consistent than the Westminster one, and it is infinitely more elegant than the Lambeth Suspension Bridge; the latter, indeed, is so irredeemably ugly, that I am almost tempted to regret that there should not be a Committee of Taste to which the designs for public works should be submitted. Before quitting this subject, I would beg to express my serious apprehensions of the present fashion for the use of wrought iron for bridges connecting leading thoroughfares in such a town as London. Our experience in the use of that material is not sufficient to justify its introduction in such positions, however justifiable it may be in railway bridges, or of similarly speculative undertakings.*

Street improvements have not kept pace in London with those in course of execution in Paris; but the changes of this description recently made here have been of themselves sufficiently remarkable, and they furnish many valuable lessons to those who know how to read the signs of the times in the various phases of architecture. When I had the honour of addressing you last year, I ventured to express my feelings of satisfaction and pride for the high character of the art displayed in the new streets of the City; and on this occasion I can but repeat my congratulations to our professional brethren who have so successfully laboured to adorn the metropolis. No doubt a severe critic might find many reasons for objecting to details of the new and gorgeous piles of warehouses and offices lately erected in the great streets of the City; but I contend that, considered comprehensively, those buildings display sound taste, keen perception of architectural beauty, fine feeling for art allied to common sense, and a sufficient amount of originality to justify us in entertaining confident hopes for the future prospects of our profession, in spite even of the defects previously alluded to in our publicly recognised art teaching. Possibly the superior character of the buildings lately erected in the City may be attributable to the fact that they have escaped, to some extent, the influence of fashion and of official pedantry; at any rate, the contrast between the architecture of the new City streets and that of the buildings erected under the influence of the Science and Art Department of our Government is so marked, that the question of the necessity for the existence of the latter expensive organisation is almost forced upon our attention. Again, we learn that public opinion is a better guide, a surer fosterer of genius, than State patronage can ever be; and the street architecture of the principal English provincial towns fully confirms this opinion. I dwell a little upon this branch of the review of our recent progress, because it seems to me that we have done, and are doing, more in domestic architecture, so to speak, than in our public buildings, in which the influence of fashionable art theories have been allowed to override the individuality of the artists themselves. The influence of these external conditions on the development of architectural taste is, however, a subject so vast, that I only allude to it now in passing, but with the hope that some of my hearers may return to its consideration hereafter. In the meantime it may be remarked that, in the provinces, the last year has witnessed the commencement of some town halls and some reproductions of the mediæval ecclesiastical buildings of singular merit, and which prove that at least the labours of the departed Prince, we began by regretting, have not been fruitless amongst us. Pardon, gentlemen, this return to the sad theme of the commencement of my lecture. As we grow older, it becomes more difficult to replace those whom we have lost, and insensibly we find that the frame of mind the poet so well describes comes over us—for then

"Our hearts have one unceasing theme,
One strain that still comes o'er,
Their breathing chords as 'twere a dream
Of joy, that's felt no more!"

And thus I am brought to the record of our losses in the course of the last twelve months. We find the list of Death's doings headed by the decease of M. Jean Baptiste Biot, who passed from this life on the 27th of January last, at the advanced period of nearly 88 years. He was a sincere lover of science. His labours connected with the Egyptian chronology were early crowned with success, and he attained merited distinction for his identifying the dates of the Egyptian and the Hindoo astronomies of that period. All architects must be obliged for the light thus thrown upon the most abstruse branch of their studies. Matthew Cotes Wyatt passed away about the same time as the preceding, for he died on the 24th of January. Mr. Wyatt was a son of the late James Wyatt, Surveyor General, and for a short time President of the Royal Academy, in which institution the son was educated. A series of works was entrusted to his care in Windsor Palace by George the Third, but his appearance in public was a statue to Lord Nelson, at Liverpool. Since that time he executed the cenotaph of the Princese Charlotte at Windsor; the monument to the late Duchess of Rutland, at Belvoir Castle; the equestrian statues of the Duke of York and the Marquis of Angle sea; the statue of George the Third, at Charing Cross; the great statue of the Duke of Wellington, at Hyde Park Corner; besides some smaller tombs and works of art. It will be advisable to allow these works to remain in the indifference to which they have sunk, for they are by no means characterised by the high principles of art that now ornament our sculpture; yet I would urge those who may seek to compare Wyatt with our times to weigh him with the tendencies of his age and to compare his works with the false taste which then prevailed; if so, Wyatt will bear the comparison. The next man we have to regret is Professor Barlow, of the Academy of Woolwich, a man whom every engineer and architect must esteem. The researches of this gentleman upon the strength of timber, and the best form to be given to railway bars, are amongst the most valued productions on the subject. Indeed, all the Professor's inquiries into the qualities of iron must be considered as text-books upon the various subjects investigated. Professor Barlow passed from us on the 1st of March last, aged about 83 years.

On the 2nd of April died Mr. James Elmes, an author on architectural legislation of eminence, who was principally known by his work upon *Architectural Dilapidations*, *The Life and Times of Sir C. Wren* a volume of *Lectures on Architecture*, and some minor publications. Mr. Elmes lived to a very great age. On the 9th of the same month, in his best days, and just as his fame was beginning to be established, John Thomas was snatched away from the future which began to spread before him, and from the brilliant prospects which seemed to crown his labours. We have few instances upon record in our profession of the fate of a man being so marked with the character of his genius as was that of Mr. Thomas, and I think that we may congratulate ourselves upon the result of his labours. He was not highly educated, he was not a genius of a description to take the world by storm; but he was purely and simply a firm believer in the importance art should bear to architecture; he was convinced that they could mutually throw light upon one another, and he laboured to make the two branches of sculpture and architectnre to which he had devoted his attention combine to work out the end he had in view. His success was justified by his labours, and in Somerleyton House and in Arlesford Hall he had surpassed himself in the fancy of his design. I would urge you to think of Mr. Thomas's success. It seems to me to be fraught with lessons of deep importance to the artists of future generations, and in proportion as they work in the spirit he infused into his work, so will they merit the good opinion of their posterity.

Happily this review will show that amongst the class of actual architects our losses in this country have been few.

Amongst our neighbours in Scotland the losses have even been fewer, for I do not know that we have any other than Mr. George Henderson, of Aberdeen, to mention; he was a good mediævalist, and erected some creditable specimens of his skill in the counties on the east coast, especially at Aberdeen, Montrose, Burnt Island, and Arbroath. He was a sensible restorer, and seems to have been rather before his age in his love for the mediæval style.

In France I am called upon to notice three deaths: viz., M. Nepveu, architect of Versailles; M. Halevy, and M. Bruaet de Baines. The first gentlemen I leave in the able hands of my friend Mr. Professor Donaldson, who proposes to address to you a few words on his loss. Mr. Halevy was the secretary of the Academy des Beaux Arts, and is death his well deserving of our deep regret, as he was the exponent of the feelings of the French educated society towards our profession, and as he possessed, to a great extent, the feeling that all lovers of art are equally entitled to consideration; the other gentlemen claimed to be ranked amongst our honorary members by the great skill he had displayed in the construction of the Museum of Havre, the Caserne des Douanes, l'Entrepot des Tabacs, and finally the Hotel de Ville of that town, and in the new buildings of the Hotel des Invalides.

Though we architects have happily escaped, death has left his mark strongly amongst the engineers, who have to regret three gentlemen wel

* Blackfriars Bridge, I may also notice, will soon cease to exist. As is well known, it was the work of one of our best architects (the elder Mylne), and it was celebrated, not only in this country, but in Europe, as of surpassing elegance and beauty. In the competition which has raged for some months past as to the designs for its successor, I cannot say I see much to admire in the result; for, unfortunately, the very worst design of the whole has been chosen. Mr. Page's three-arched bridge was a grand idea, though defective in detail. The bridge about to be erected is in five segmental arches of iron with stone piers, and the architectural features of those piers, and other adornments, are highly objectionable.

known to myself, and with two of whom I have acted professionally to a considerable extent.

The first was James Walker; he had an immense practice, lived to a great age, and was certainly one of our most successful private engineers. He was one of the earliest supporters of the Institution of Civil Engineers, and I recollect well belonging to that now flourishing body with him, when, many years ago, it met in an "upper chamber" in the Adelphi, with the humblest of all arrangements and applications; but Telford was the President, and under his great name the society soon became important; and after his death, Mr. Walker was elected to fill his place, a position he retained with success for many years. The profession of engineering owes a debt of gratitude of a singular kind to James Walker, for he succeeded in establishing the enormous scale of charges now universally adopted by engineerss, which leave all the earnings of architects far behind, aud are very different indeed from those recorded and quoted by Mr. Smiles in his charming *Lives of the Engineers.*

John Errington, the partner and friend of Joseph Locke, died most unexpectedly in July. He was content to live quietly under the shadow of his great associate, and though a man of ability, I am not aware of any great work which may be attributed to him.

With Mr. Locke and Mr. Errington in earlier days I had much to do on the Paris and Rouen, the Rouen and Havre, the Caledonian, Scottish Central, and other lines of railway, where I was the architect, as they were the engineers. They confined themselves strictly to their departments; Mr. Locke having at an early period laid down the rule that as regarded buildings, "an engineer's functions ceased with the platforms." One of Mr. Errington's latest works, and which I had the pleasure of co-operating with him, was the Yeovil and Exeter Railway. It was his last work, as it probably will be mine; and I may be permitted to remark, as somewhat curious, that influenced either by the "Genius loci," or by other considerations, mediæval architecture was introduced. At Carlisle and at Perth, and more recently on the Exeter line, I have done my best to mould the forms and modes of thinking of mediæval architects to the unusual requirements of railways. At Rouen, in the two stations, at Havre, and at Southampton, Gosport, Blackwall, and other places, I adhered to the more usual styles, and perhaps with better success.

The last name I mention is that of James Berkley, who fell a sacrifice to the effects of the baneful climate of India, at a comparatively early period of his life; he was a pupil of the younger Stephenson, who recommended him to this appointment; he did ample justice to the recommendation; his works in India in ascending the Ghauts are spoken of in the highest terms as monuments of engineering skill and perseverance.

ROYAL INSTITUTION OF GREAT BRITAIN.

ON FORCE.

By JOHN TYNDALL, ESQ., F.R.S.

The existence of the International Exhibition suggested to our Honorary Secretary the idea of devoting the Friday evenings after Easter of the present year to discourses on the various agencies on which the material strength of England is based. He wished to make iron, coal, cotton, and kindred matters the subjects of these discourses; opening the series by a discourse on the Great Exhibition itself, and he wished me to finish the series by a discourse on "Force" in general. For some months I thought over the subject at intervals, and had devised a plan of dealing with it; but three weeks ago I was induced to swerve from this plan, for reasons which shall be made known towards the conclusion of the discourse.

We all have ideas more or less distinct regarding force. We know in a general way what muscular force means, and each of us would less willingly accept a blow from a pugilist than have his ears boxed by a lady. But these general ideas are not now sufficient for us; we must learn how to express numerically the exact mechanical value of the two blows; this is the first point to be cleared up.

A sphere of lead weighing 1lb. was suspended at a height of 16ft. above the theatre floor. It was liberated, and fell by gravity. That weight required exactly a second to fall to the earth from that elevation, and the instant before it touched the earth it had a velocity of 32ft. a second, That is to say, if at that instant the earth were annihilated and its attraction annulled, the weight would proceed through space at the uniform velocity of 32ft. a second.

Suppose that instead of being pulled downward by gravity, the weight is cast upward in opposition to the force of gravity; with what velocity must it start from the earth's surface in order to reach a height of 16ft.? With a velocity of 32ft. a second. This velocity imparted to the weight by the human arm, or by any other mechanical means, would carry the weight up to the precise height from which it has fallen.

Now the lifting of the weight may be regarded as so much mechanical work. I might place a ladder against the wall, and carry the weight up a height of 16ft., or I might draw it up to this height by means of a string and pulley, or I might suddenly jerk it up to a height of 16ft. The amount of work done in all these cases, as far as the raising of the weight is concerned, would be absolutely the same. The absolute amount of work done depends solely upon two things: first of all on the quantity of matter that is lifted; and secondly, on the height to which it is lifted. If you call the quantity or mass m, and the height through which it is lifted h, then the product of m into h, or $m\,h$, expresses the amount of work done.

Supposing, now, that instead of imparting a velocity of 32ft. a second to the weight we impart twice this speed, or 64ft. a second; to what height will the weight rise? You might be disposed to answer, "To twice the height." But this would be quite incorrect. Both theory and experiment inform us that the weight would rise to four times the height: instead of twice 16, or 32ft., it would reach four times 16, or 64ft. So, also, if we treble the starting velocity, the weight would reach nine times the height; if we quadruple the speed at starting, we attain sixteen times the height. Thus, with a velocity of 128ft. a second at starting, the weight would attain an elevation of 256ft. Supposing we augment the velocity of starting seven times, we should raise the weight to 49 times the height, or to an elevation of 784ft.

Now the work done—or, as it is sometimes called, the *mechanical effect*—as before explained, is proportional to the height, and as a double velocity gives four times the height, a treble velocity nine time the height, and so on, it is perfectly plain that the mechanical effect increases as the square of the velocity. If the mass of the body be represented by the letter m, and its velocity by v, then the mechanical effect would be represented by $m\,v^2$. In the case considered, I have supposed the weight to be cast upward, being opposed in its upward flight by the resistance of gravity; but the same holds true if I send the projectile into water, mud, earth, timber, or other resisting material. If, for example, you double the velocity of a cannon-ball, you quadruple its mechanical effect. Hence the importance of augmenting the velocity of a projectile, and hence the philosophy of Sir William Armstrong in using a 50lb. charge of powder in his recent striking experiments.

The measure, then, of mechanical effect is the mass of the body multiplied by the square of its velocity.

Now in firing a ball against a target the projectile, after collision, is often found hissing hot. Mr. Fairbairn informs me that in the experiments at Shoeburyness it is a common thing to see a flash of light, even in broad day, when the ball strikes the target. And if I examine my lead weight after it has fallen from a height I also find it heated. Now here experiment and reasoning lead us to the remarkable law that the amount of heat generated, like the mechanical effect, is proportional to the product of the mass into the square of the velocity. Double your mass, other things being equal, and you double your amount of heat; double your velocity, other things remaining equal, and you quadruple your amount of heat. Here then we have common mechanical motion destroyed and heat produced. I take this violin bow and draw it across this string. You hear the sound. That sound is due to motion imparted to the air, and to produce that motion a certain portion of the muscular force of my arm must be expended. We may here correctly say, that the mechanical force of my arm must be converted into music. And in a similar way we say that the impeded motion of our descending weight, or of the arrested cannon-ball, is converted into heat. The mode of motion changes, but it still continues motion; *the motion of the mass is converted into a motion of the atoms of a mass*; and these small motions, communicated to the nerves, produce the sensation which we call heat. We, moreover, know the amount of heat which a given amount of mechanical force can develope. Our lead ball, for example, in falling to the earth generated a quantity of heat sufficient to raise the temperature of its own mass three-fifths of a Fahrenheit degree. It reached the earth with a velocity of 32ft. a second, and forty times this velocity would be a small one for a rifle bullet; multiplying three-fifths by the square of 40, we find that the amount of heat developed by collision with the target would, if wholly concentrated in the lead, raise its temperature 960 degrees. This would be more than sufficient to fuse the lead. In reality, however, the heat developed is divided between the lead and the body against which it strikes; nevertheless, it would be worth while to pay attention to this point and to ascertain whether rifle bullets do not, under some circumstances, show signs of fusion.

From the motion of sensible masses, by gravity and other means, the speaker passed to the motion of atoms towards each other by chemical affinity. A collodion balloon filled with a mixture of chlorine and hydrogen was hung in the focus of a parabolic mirror, and in the focus of a second mirror 20ft. distant a strong electric light was suddenly generated; the instant the light fell upon the balloon, the atoms within it fell together with explosion, and hydro-chloric acid was the result. The burning of charcoal in oxygen was an old experiment, but it had now a significance beyond what it used to have; we now regard the act of combination on the part of the atoms of oxygen and coal exactly as we regard the clashing of a falling weight against the earth. And the heat produced in both cases is referable to a common cause. This glowing diamond, which burns in oxygen as a star of white light, glows and burns in consequence of the falling of the atoms of oxygen against it. And could we measure the velocity of the atoms when they clash, and could we find their number and weight, multiplying the mass of each atom by the square of its velocity, and adding all together, we should get a number representing the exact amount of heat developed by the union of the oxygen and carbon.

Thus far we have regarded the heat developed by the clashing of sensible masses and of atoms. Work is expended in giving motion to these atoms or masses, and heat is developed. But we reverse this process daily, and by the expenditure of heat execute work. We can raise a weight by heat; and in this agent we possess an enormous store of mechanical power. This pound of coal, which I hold in my hand, produces by its combination with oxygen an amount of heat which, if mechanically applied, would suffice to raise a weight of 100lbs. to a height of 20 miles above the earth's surface. Conversely, 100lbs. falling from a height of 20 miles, and striking against the earth, would generate an amount of heat equal to that developed by the combusition of a pound of coal. Wherever work is done by heat, heat disappears. A gun which fires a ball is less heated than one which fires blank cartridge. The quantity of heat communicated to the boiler of a working steam-engine is greater than that which could be obtained from the re-condensation of the steam after it had done its work; and the amount of work performed is the exact equivalent of the amount of heat lost. Mr. Smyth informed us in his interesting discourse, that we dig annually 84 millions of tons of coal from our pits. The amount of mechanical force represented by this quantity of coal seems perfectly fabulous. The combustion of a single pound of coal, supposing it to take place in a minute, would be equivalent to the work of 300 horses; and if we suppose 108 millions of horses working day and night with unimpaired strength, for a year, their united energies would enable them to perform an amount of work just equivalent to that which the annual produce of our coal-fields would be able to accomplish.

Comparing the energy of the force with which oxygen and carbon unite together, with ordinary gravity, the chemical affinity seems almost infinite. But let us give gravity fair play; let us permit it to act throughout its entire range. Place a body at such a distance from the earth that the attraction of the earth is barely sensible, and let it fall to the earth from this distance. It would reach the earth with a final velocity of 36,747ft. in a second; and on collision with the earth the body would generate about twice the amount of heat generated by the combustion of an equal weight of coal. We have stated that by falling through a space of 16ft. our lead bullet would be heated three-fifths of a degree; but a body falling from an infinite distance has already used up 1,299,999 parts out of 1,300,000 of the earth's pulling power, when it has arrived withih 16ft. of the surface; on this space only $\frac{1}{1300000}$ths of the whole force is exerted.

Let us turn our thoughts for a moment from the earth towards the sun. The researches of Sir John Herschell and Mr. Pouillett have informed us of the annual expenditure of the sun as regards the heat; and by an easy calculation we ascertain the precise amount of the expenditure which falls to the share of our planet. Out of 2300 million parts of light and heat the earth receives one. The whole heat emitted by the sun in a minute would be competent to boil 12,000 millions of cubic miles of ice-cold water. How is this enormous loss made good? Whence is the sun's heat derived, and by what means is it maintained? No combustion, no chemical affinity with which we are acquainted would be competent to produce the temperature of the sun's surface. Besides, were the sun a burning body merely, its light and heat would assuredly speedily come to an end. Supposing it to be a solid globe of coal, its combustion would only cover 4600 years of expenditure. In this short time it would burn itself out. What agency then can produce the temperature and maintain the outlay? We have already regarded the case of a body falling from a great distance towards the earth, and found the heat generated by its collision would be twice that produced by the combustion of an equal weight of coal. How much greater must be the heat developed by a body falling towards the sun! The maximum velocity with which a body can strike the earth is about 7 miles in a second; the maximum velocity with which it can strike the sun is 390 miles in a second. And as the heat developed by the collision is proportional to the square of the velocity destroyed, an asteroid falling into the sun with the above velocity would generate about 10,000 times the quantity of heat generated by the combustion of an asteroid of coal of the same weight. Have we any reason to believe that such bodies exist in space, and that they may be raining down upon the sun? The meteorits flashing through the air are small planetary bodies, drawn by the earth's attraction, and entering our atmosphere with planetory velocity. By friction against the air they are raised to incandesence and caused to emit light and heat. At certain seasons of the year they shower down upon us in great numbers. In Boston 240,000 of them were observed in nine hours. There is no reason to suppose that the planetary system is limited to "vast masses of enormous weight;" there is every reason to believe that space is stocked with smaller masses, which obey the same laws as the large ones. That lenticular envelope which surrounds the sun, and which is known to astronomers as the Zodiacal light, is probably a crowd of meteors; and moving as they do in a resisting medium they must continually approach the sun. Falling into it, they would be competent to produce the heat observed, and this would constitute a source from which the annual loss of heat would be made good. The sun, according to this hypothesis, would be continually growing larger; but how much larger? Were our moon to fall into the sun it would develope an amount of heat sufficient to cover one or two years' loss; and were our earth to fall into the sun a century's loss would be made good. Still, our moon and our earth, if distributed over the surface of the sun, would utterly vanish from perception. Indeed, the quantity of matter competent to produce the necessary effect would, during the range of history, produce no appreciable augmentation in the sun's magnitude. The augmentation of the sun's attractive force would be more appreciable. However this hypothesis may fare as a representant of what is going on in nature, it certainly shows how a sun might be formed and maintained by the application of known thermo-dynamic principles.

Our earth moves in its orbit with a velocity of 68,040 miles an hour. Were this motion stopped, an amount of heat would be developed sufficient to raise the temperature of a globe of lead of the same size as the earth 384,000 degrees of the centigrade thermometer. It has been prophesied that "the elements shall melt with fervent heat." The earth's own motion embraces the conditions of fulfilment; stop that motion, and the greater part, if not the whole, of the mass would be reduced to vapour. If the earth fell into the sun, the amount of heat developed by the shock would be equal to that developed by the combustion of 6435 earths of solid coal.

There is one other consideration connected with the permanence of our present terrestial conditions, which is well worthy of our attention. Standing upon one of the London bridges, we observe the current of the Thames reversed, and the water poured upward twice a-day. The water thus moved rubs against the river's bed and sides, and heat is the consequence of this friction. The heat thus generated is in part radiated into space, and then lost, as far as the earth is concerned. What is it that supplies this incessant loss? The earth's rotation. Let us look a little more closely at the matter. Imagine the moon fixed, and the earth turning like a wheel from west to east in its diurnal rotation. Suppose a high mountain on the earth's surface; on approaching the the moon's meridian, that mountain is, as it were, laid hold of by the moon, and forms a kind of handle by which the earth is pulled more quickly round. But when the meridian is passed the pull of the moon on the mountain would be in the opposite direction, it now tends to diminish the velocity of rotation as much as it previously augmented it; and thus the action of all fixed bodies on the earth's surface is neutralised. But suppose the mountain to lie always to the east of the moon's meridian, the pull then would be always exerted against the earth's rotation, the velocity of which would be diminished in a degree corresponding to the strength of the pull. *The tidal wave occupies this position*—it lies always to the east of the moons's meridian, and thus the waters of the ocean are in part dragged as a brake along the surface of the earth; and as a brake they must diminish the velocity of the earth's rotation. The diminution, though inevitable, is however, too small to make itself felt within the period over which observations on the subject extend. Supposing then that we turn a mill by the action of the tide, and produce heat by the friction of the millstones; that heat has an origin totally different from the heat produced by another mill which is turned by a mountain stream. The former is produced at the expense of the earth's rotation, the latter at the expense of the sun's radiation.

The sun, by the act of vaporisation, lifts mechanically all the moisture of our air. It condenses, and falls in the form of rain; it freezes, and falls as snow. In this solid form it is piled upon the Alpine heights, and furnishes materials for the glaciers of the Alps. But the sun again interposes, liberates the solidified liquid, and permits it to roll by gravity to the sea. The mechanical force of every river in the world, as it rolls towards the ocean, is drawn from the heat of the sun. No streamlet glides to a lower level without having been first lifted to the elevation from which it springs by the mighty power of the sun. The energy of winds is also due entirely to the sun; but there is still another work which he performs, and his connection with which is not so obvious. Trees and vegetables grow upon the earth, and when burned they give rise to heat, and hence to mechanical energy. Whence is this power derived? You see this oxide of iron, produced by the falling together of the atoms of iron and oxygen; here, also, is a transparent gas which you cannot now see—carbonic acid gas—which is formed by the falling together of carbon and oxygen. These atoms thus in close union resemble our lead weight while resting upon the earth; but I can wind up the weight and prepare it for another fall; and so these atoms can be wound up, separated from each other, and thus enabled to repeat the process of combination. In the building of plants, carbonic acid is the material from which the carbon of the plant is derived, and the solar beam is the agent which tears the atoms asunder, setting the oxygen free, and allowing the carbon to aggregate in woody fibre. Let the solar rays fall upon a surface of sand; the sand is heated, and finally radiates away as much heat as it receives. Let the same beams fall upon a forest; the quantity of heat given back is less than it receives, for the energy of a portion of the sunbeams is invested in building up the trees in the manner indicated. Without the sun the reduction of the carbonic acid cannot be effected, and an amount of sunlight is consumed exactly equivalent to the molecular work done. Thus trees are formed; thus the cotton on which Mr. Bazley discoursed last Friday is formed. I ignite this cotton, and it flames; the oxygen again unites with its beloved carbon; but an amount of heat equal to that which you see produced by its combustion was sacrificed by the sun to form that bit of cotton.

But we cannot stop at vegetable life, for this is the source, mediate or immediate, of all animal life. The sun severs the carbon from its oxygen; the animal consumes the vegetable thus formed, and in its arteries a reunion of the severed elements takes place, and produce animal heat. Thus, strictly speaking, the process of building a vegetable is one of winding up, the process of building an animal is one of running down. The warmth of our bodies and every mechanical energy which we exert trace their lineage directly to the sun. The fight of a pair of pugilists, the motion of an army, or the lifting of his own body up mountain slope by an Alpine climber, are all cases of mechanical energy drawn from the sun. Not, therefore, in a poetical, but in a purely mechanical sense, are we children of the sun. Without food we should soon oxidize our own bodies. A man weighing 150lbs. has 64lbs. of muscle; but these, when dried, reduce themselves to 15lbs. Doing an ordinary day's work for eighty days, this mass of muscle would be wholly oxidized. Special organs which do more work would be more quickly oxidized: the heart, for example, if entirely unsustained, would be oxidized in about a week. Take the amount of heat due to the direct oxidation of a given amount of food; a less amount of heat is developed by this food in the working animal frame, and the missing quantity is the exact equivalent of the mechanical work which the body accomplishes.

I might extend these considerations: the work, indeed, is done to my hand, but I am warned that I have kept you already too long. To whom, then, are we indebted for the striking generalizations of this evening's discourse? All that I have laid before you is the work of a man of whom you have scarcely ever heard. All that I have brought before you has been taken from the labours of a German physician, named Mayer. Without external stimulus, and pursuing his profession as town physician in Heilbronn, this man was the first to raise the conception of the interaction of natural forces to clearness in his own mind. And yet he is scarcely ever heard of in scientific lectures, and even to scientific men his merits are but partially known. Led by his own beautiful researches, and quite independent of Mayer, Mr. Joule published his first paper on the "Mechanical Value of Heat," in 1843; but in 1842 Mayer had actually calculated the mechanical equivalent of heat from data which a man of rare originality alone could turn to account. From the velocity of sound in air, Mayer determined the mechanical equivalent of heat. In 1845 he published his Memoir on "Organic Motion," and applied the mechanical theory of heat in the most fearless and precise manner to vital processes. He also embraced the other natural agents in his chain of conservation. In 1853 Mr. Waterston proposed, independently, the meteoric theory of the sun's heat, and in 1854 Professor William Thomson applied his admirable mathematical powers to the development of the theory; but six years proviously the subject had been handled in a masterly manner by Mayer, and all that I have said on this subject has been derived from him. When we consider the circumstances of Mayer's life, and the period at which he wrote, we cannot fail to be struck with astonishment at what he has accomplished. Here was a man of genius working in silence, animated solely by a love of his subject, and arriving at the most important results, some time in advance of those whose lives were entirely devoted to Natural Philosophy. It was the accident of bleeding a feverish patient at Java, in 1840, that led Mayer to speculate on these subjects. He noticed that the venous blood in the tropics was of a much brighter red than in colder latitudes, and his reasoning on this fact led him into the laboratory of natural forces, where he has worked with such signal ability and success. Well, you will desire to know what has become of this man. His mind gave way—he became insane, and he was sent into a lunatic asylum. In a biographical dictionary of his country it is stated that he died there; but this is incorrect. He recovered, and I believe is at this moment a cultivator of vineyards in Heilbronn.

NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

OBSERVATIONS ON THE MINERAL SECTION OF THE INTERNATIONAL EXHIBITION OF 1862.

By N. Wood, Esq., President.

Having had an opportunity, as a Juror in Class I. (viz., Mining, Quarrying, Metallurgy, and Mineral Products), of examining the minerals exhibited in the International Exhibition, particularly the Coals and Mining Machinery, I think it might be acceptable to the Institute if I made a few observations on this important class, by which your attention might, with more facility, be directed to that part of the section comprising the different varieties of coal, and the various descriptions of machinery connected with the working, ventilating, and safety of coal mining.

I shall, therefore, give you a short epitome of the different specimens of coal exhibited from the different countries represented at the Exhibition, referring you to the numbers in the Catalogue in which such specimens are described, and to their position in the building; and the same with the machinery. It must, however, be understood, that my intention is to rather produce a condensed catalogue than to give any detailed account of the different specimens. More time, and a more minute inspection and investigation, may enable me, at a future period, to give a more full and detailed statement of the results of this great Exhibition, in illustrating a most important branch of science and commerce.

I may, first of all, state the great pleasure felt by all with whom I have conversed, by the marked improvement in all classes of objects of the Exhibition of 1862, over that of 1851, and of the importance, in a statistical and scientific point of view, and of the vast utility of such exhibitions at successive and not too distant periods of time. The contrast between 1851 and 1862 cannot fail to produce most important results.

I think it likewise my duty, in making these observations, to do justice to our Foreign contributors in their efforts to illustrate this important class. The very great care and expense which have been bestowed upon the collection of specimens, the manner in which they are classified, and the beautiful illustrative maps, plans, and sections, do them infinite credit; and I feel the mining interests of Great Britain in particular, and of other nations generally, are deeply obliged to them for the efforts—I may say successful efforts—they have made, illustrative of Class I. I, of course, pass over the other classes, not because they are not equally interesting, but because they do not come within the scope of my observations.

British Collection.

Commencing, therefore, with the British part of the Exhibition; as regards this class, as might be expected, the specimens of coal are more bulky than those exhibited by the foreigners, on account of the relative distances they have had to be conveyed. The British specimens are, in several cases, the entire thickness of the coal beds; whilst the specimens of foreigners are smaller specimens, certainly, in several cases, beautifully arranged. But I must not omit to state that the largest specimen of coal exhibited is from a very distant part of the British dominions, viz., the entire thickness of a bed of coal, of thirty-four feet, from Nova Scotia. This is placed upright, as in nature, and is certainly a most surprising column of coal; and there are likewise in the Zollverein collection some specimens of coal of the entire thickness of each bed.

As I have previously stated, I have abstracted from the general catalogue, lists of the different descriptions of coal and other articles, which I have drawn up in a tabular form, for more easy reference. I have, as regards coal, commenced with peat, followed by lignite, brown coal, cannel coal, common coal, and anthracite; then patent fuel or coal bricks, and coke; and then the machinery. Retaining this classification, it will be seen in the British collection that few specimens of peat are exhibited, though there are some specimens of compressed peat which are interesting. Of lignite there is not, I believe, one specimen; neither is there any specimen of brown coal. Of the best household coal there are few specimens indeed, especially from the far-famed Wallsend coals of Northumberland and Durham. There are two or three specimens of gas and coking coal from that coal field; but of the important class of steam coal, there is only one specimen of the regular seam, which certainly is not of the entire thickness of the bed of coal. There are numerous specimens of the various beds of coal found in the counties of Nottingham, Derby, York, Lancashire, Somerset, and in the Forest of Dean, and Scotland. The South Wales steam coal is extensively illustrated in specimens, several large blocks, the thickness of the beds; and there are some interesting specimens of cannel coal, especially one from Leeswood Colliery, recently discovered, of a very rich description; and there is one specimen of Irish coal. Of patent fuel there are several specimens; and of coke there are three or four specimens only. All these coals and mineral products are placed in the South Court, Eastern Annexe, and will be found under the numbers given in the annexed table. I may add, that it is not my intention to attempt any description of the various minerals accompanying the coal measures, but I may mention that there are some beautiful specimens of hematite and other iron ores, and some elaborate maps and sections illustrative of these ores. There are likewise some collections of specimens showing the entire strata met with in sinking some of the coal pits. In lead, the specimens of ore, spar, and other products, with maps and sections, of the Beaumont lead mines, are very conspicuous.

In the same, and in other parts of the building, we have nine different descriptions of safety-cages, four of safety-fusees, several different descriptions of safety-lamps, interesting especially from the different attempts made to extinguish the flame if the top of the lamp is surreptitiously removed, a description of an improved furnace, a model of the recent fittings up of an apparatus for drawing coals, a jointed cast-iron prop, canvas brattice, model showing the mode of conveyance of coals underground, and of a pump for pumping water at great distances from the shaft connected therewith, together with the model of the steam engine employed. There are also some models of mine ventilators, and also of the mode of ventilating mines. Altogether, the whole collection is well worth the inspection and study of the mining engineer.

British Possessions.

Of the British Possessions we have a most interesting collection of specimens of coal from the different coal-fields of India, arranged and illustrated by Professor T. Oldham, with statistical accounts and analyses of the various coals. Also coals from Assam, Cuttack, Chota Nagpore, Chittagong, and other localities; and also petroleum from Assam and naphtha from Burmah and Akyab. Professor Oldham likewise furnishes geological specimens from Assam and other rock formations, and a complete series of fossil specimens. This collection is, as a whole, extremely interesting.

From New Brunswick is a specimen of coal called albertite coal, more resembling bitumen than ordinary coal, which is worth inspection.

From New South Wales we have a large collection of specimens from eleven seams of coal, specimens of super and sub-carboniferous rocks, a geological map and a sheet of sections by Mr. Keene, Inspector of coal-fields, and also specimens of coal from several individual collieries, and what is most important is, that the Commissioners of that colony have had printed a most valuable catalogue, a statement illustrative of the various woods of that important colony, and of the mineral products, described most scientifically and minutely, including statistics and details of the several beds of coal and other products. I need scarcely add, that all this almost demands from the mining engineer a minute inspection and study; and I may also mention, that if he is disposed to embark in the gold diggings, the maps and sections, and most beautifully arranged collection of specimens of the strata passed through in the diggings for gold, may be of great service to him.

From New Zealand there are a few specimens of coal from different localties.

From Nova Scotia we have coal from the Sydney mines, the Glass Bay mines, and the Joggings, and oil coal from Fraser's mines. But *the* specimen is the column of coal, thirty-four feet in height, the entire thickness of the bed of coal at the Albion mines, by Mr. James Scott, formerly viewer at Black Boy Colliery. This bed of coal, like all thick beds, is divided by thin layers of band at different places, but not materially diminishing the entire thickness. This, of course, will be visited.

From Tasmania, there are numerous boxes containing specimens of various coals, sent by different parties, but owing to some misadventure in the transmission the several boxes cannot be at present identified; no doubt this will be rectified. But as the several coals are described in the general catalogue under the different numbers I have abstracted, their inspection is worth a visit. There being both bituminous and anthracite coal—and the beds being both numerous and of considerable thickness—the thickest is twelve-and-a-half feet.

Foreign Coal and Minerals.

The first, alphabetically, is the Belgian coal, and from this country a splendid set of specimens has been sent both of minerals and of strata illustrative of the geological position of the coal and other measures, as well as maps and sections illustrative thereof, and of the various beds of coal with all the contortions of the beds peculiar to that coal field, as well as that of Prussia, and some parts of France. The specimens of coal are mostly common coal, but their inspection, as well as that of the rocks with which they are associated, will well repay either the mining engineer or the geologist the trouble of a most minute investigation. As regards the maps and sections and the contortions of the various beds, these will, I doubt not, puzzle the most ingenious investigator of nature's freaks and results. The arrangement of the specimens deserve special commendation.

In addition to the specimens of coal, strata, and minerals, there are plans, sections, and elevation of the above ground machinery of an extensive colliery, exhibiting in a very beautiful manner the entire above ground machinery, no doubt of the latest improvement, with all the shaft apparatus, pumping machinery, &c. There are also, a plan of the mode of working the Belgian mines,—models of a ventilating machine, with plans illustrative thereof,—and of a sinking apparatus for sinking through quicksands, a soft wet strata. There are, likewise, models of three descriptions of safety-cages in the North-Eastern Annexe, which are worth inspection—and also a mode of lining shafts. Altogether the Belgian exhibition is first-rate, and will repay inspection, the minerals particularly.

Of the production of the Brazils there are only two specimens of coal exhibited, a specimen of coal from Laguna in the Province of Santa Catharina, —and lignite from Ouro Preto Minas Geraes. The lignite should be examined. There are specimens of asphalte from Denmark.

We now come to France, which is most elaborately represented in every respect, and as regards class I. most interestingly. It would, of course, extend my observations to too great an extent to go into details. It is only, therefore, necessary to state, that in specimens of lignite, coal of different varieties, coke, and patent fuel, these minerals are beautifully illustrated. The Committee of Coal Proprietors of the department of the Loire, and the Mining Company of Montccl St. Etienne, have sent collections extremely interesting and instructive. The collection of specimens of coal and patent fuel, with sections, &c., of the La Grand Combe Mines in the department Gard, working 800,000 tons of coal, and producing about 61,000 tons of coke and 67,000 tons of patent fuel annually, is exceedingly good. The maps of the Valenciennes coal-fields, the details of workings, the beautiful illustrative sections of the contortions of the coal beds, and other detailed maps, are splendidly illustrative and ingenious; and the maps, sections of strata, and specimens of the prolongation of that coal-field into the terminal field of Calais, are deeply interesting and instructive. The lignite of Aix, near Marseilles, where 130,000 tons annually are worked, requires from the mining engineers of England, where no lignite almost is produced, special examination and study, some specimens of lignite being quite as compact as the regular coal. The products, paraffin, and the beautiful Magenta dye, exhibited in this court, are exceedingly interesting. The French, likewise, exhibit models of safety-lamps, two models of ventilating machines, and a plan of timber tubbing for shafts. A plan of carbonization of coal, or patent fuel, is well worth looking at ,and also a plan of washing minerals.

The next great collection is that from Austria, and it is indeed a most interesting collection. We have in this collection all the descriptions of fuel which we in the north of England are least of all conversant with, and which, then, demands our special study and attention. We have specimens of peat, of which a million of tons is consumed annually as fuel and for refining iron We have lignite from Upper Austria, Lombardy, Venetia, Lower Austria, Styria, Moravia, and Hungary; brown coal in abundance from Bohemia and elsewhere, and common coal from various places, and patent fuel. These are illustrated under the supervision of the Geological Institution, I.R., Vienna, by, I believe, about 240 boxes of specimens, by ten special geological maps, and several volumes of "Transactions." It is scarcely necessary to say, that this is a field of instruction, study, and interest for several days, and for which we owe a deep debt of gratitude to the gentlemen connected with that institution. We have, likewise, individual specimens, from coal proprietors and companies, of mineral productions, and I may add, that the specimens do not consist alone of coal, but of the rocks associated therewith, and of mineral ores and strata generally.

From Bavaria we have specimens of brown coal, and from Hanover some jet coal and anthracite.

The next great collection is that of Prussia, or the Zollverin, and like Austria, the different varieties of mineral fuel is diffusively illustrated. In the article of peat there are several specimens, in lignite a few specimens, in brown coal about twelve specimems, and in common coal about forty-eight specimens, in anthracite one specimen, in patent fuel four specimens, and coke nine specimens, all of course from different localities. The study of the brown coal will be found to be very interesting. There is likewise exhibited a large collection of maps, illustrative of the peculiar formation of the Prussian beds of coal, which, like the north of France and Belgium, are exceedingly contorted, and which are, I believe, beyond the power of man to unravel. These maps will be extremely well worth the study of the young, and even some of the old and practised engineers; and it is only dueto the Prussians to state, that the iron ores, and other materials connected therewith, and with the coal strata, are most extensively and beautifully illustrated by substantial and most numerous specimens. Great part of the coal is from the coal-field of the Ruhr, but there are specimens from, I believe, all the coal producing districts of Prussia.

In the remaining countries producing coal, being on a much more limited scale, the specimens are not so numerous. There are, however, a few specimens of peat, lignite, and coal from Italy; lignite, common coal, and anthracite from Portugal; peat and coal from Russia; lignite, coal, and coke from Spain; and two or three specimens of coal from Uruguay.

Having thus made a few hasty observations on the different varieties of coal and other productions of fuel, and some of the machinery connected therewith, if these observations are the means of directing your attention to those objects which are within the peculiar province of a mining engineer, I shall be most glad. I, however, beg to add, that it will be my duty, if I am spared to do so, to bring the subject of the different varieties of coal, their specific geological position, and all their peculiarities, before the Institute at the close of the Exhibition. I hope to be able to secure some of the specimens illustrative of the different varieties of coal, for the Institute; and I trust that the members, and especially the young members, will be well up on the subject when the time for such discussion arrives.

CORRESPONDENCE.

We cannot hold ourselves responsible for the opinions of our Correspondents.

HEAT AND FORCE.

To the Editor of The Artizan.

A general and vague knowledge of some connection between heat and mechanical energy must have existed among the pioneers of science from the most remote antiquity; and we have historical evidence of the energy of fire having been applied to produce motion, and even small amounts of mechanical work two thousand years ago.

The attempt to reduce to a physical theory, or system of principles, the known laws which connect heat with mechanical energy is, comparatively, very recent; and the science of thermodynamics, as now generally accepted, is yet in its infancy, though its developement has been rapid under the fostering care of many of the first scientific men of the day. This infant science has been already, in many cases, brought to bear successfully on the rational investigation of thermic phenomena; but it is a matter of surprise and regret to the intelligent mechanical engineer that a physical theory which, applied to some grand cosmical phenomena, gives results bearing the impress of probable correctness, should be still obviously erroneous as applied to the working of the commonest steam engine.

It must appear presumptuous to call in question the harmonizing results deduced by such master minds as Clausius, Mayer, and Regnault on the Continent, and Professors Thomson and Rankine, and Dr. Joule in England, all co-operating in this novel field of scientific research, which is the more interesting because professedly practical as regards our thermic prime movers; but after an unremitting study of the theory and practice of heat engines extending over a period of twenty years, and involving technical and commercial considerations of importance to me, I feel authorised to call attention to what I consider to be serious errors in the practical application of the science of thermodynamics as at present received; and to the candour and love of truth which should distinguish such eminent men, not less than their intellectual superiority, I appeal for an examination of a few remarks which I will proceed to submit to their attention.

The mechanical equivalence of heat supposes the conversion of the motion, or momentum, of masses of matter into the molecular motion of material particles, and *vice versa.* Thus, if a ball of lead, falling freely through space, be suddenly stopped in its descent, its momentum will be divided between its own particles and those of the obstructing body against which it has impinged, in the shape of molecular motion; and experiment proves that heat is the result. The individual movements thus generated in the molecules affect our nerves with a well known sensation, and cause an expansion and consequent rise in the mercurial column of the thermometer. These effects result from a communication of part of the molecular motion of the hotter to the colder body; and it may be interesting to notice, in passing a remark of Professor W. Thomson, that, as heat is eminently diffusive, one result of the cosmical application of the mechanical equivalence of heat would be a general tendency to equilibrium and rest in the universe.

If the descent of the leaden ball be moderated by attaching it to a cord wound round a barrel, and causing it to agitate a mass of water by means of revolving flyers, or similar contrivance, the ball will strike the ground with a comparatively slight impulse, and it is evident that the momentum given out in its descent, or rather energy equivalent to the momentum which would have been generated had the ball fallen freely, has been communicated to the water. This imparted energy first affects the water bodily, causing a general agitation of the mass; but this agitation is, in a degree, converted simultaneously into molecular movements of the liquid by the friction of the particles on each other, and on the solid surfaces with which they are in contact; and at the end of the operation when the liquid comes to a state of rest, an equivalent of the momentum lost by the descending weight may be supposed, theoretically, to exist in the molecules of the water, constituting the phenomenon called heat, or temperature.

From a long series of experiments it was ascertained by Dr. Joule that the mechanical work performed by a weight of 1lb., descending through 772ft., being expended in agitating 1lb. of liquid water, would raise the temperature of the water 1 degree of Fahrenheit. This is Joule's thermodynamical equivalent, and its application to the practical phenomena of the steam engine is based on the assumption that heat and mechanical work are mutually and reciprocally convertible. But it will be found, on candid consideration, that this assumption involves a curious fallacy, which greatly invalidates the modern science of thermodynamics in its practical application to our heat engines.

Professor Rankine, in his *Manual of the Steam Engine,* &c., p. 529, says:—"It is a matter of ordinary observation that heat, by expanding bodies, is a source of mechanical energy; and conversely, that mechanical energy, being expended eith in compressing bodies or in infriction, is a source of heat." Here the fallacy is evident. It is true, in a certain sense, that heat, by expanding bodies, is a source of mechanical energy; but it is a grave mistake to suppose that mechanical energy expended in compressing bodies, *apart from the idea of friction,* is a direct source of heat. It is only a means of concentrating heat, or converting latent into sensible, as it would be called in the common language of physics. This is strikingly obvious in the case of elastic fluids, but it may probably hold good of substances generally. It is true that by the tumultuous expansion of an elastic fluid heat is produced equivalent to the work which might have been performed by its moderated expansion; and as work performed by moderated expansion may be "converted into heat" by friction, we perceive that the energy expended in compressing an elastic fluid may be *indirectly* a source of heat; but this is not the meaning conveyed by the announcement that "mechanical energy expended in compressing bodies is a source of heat."

It is difficult, practically, to separate the effects of compression from those of friction, as we generally see them less or more combined in thermic phenomena. Thus when the blacksmith lights his match from the point of an old nail made red hot by a few dexterous blows of the hammer, we imagine that the heat is developed chiefly by the conversion of part of the motion of the mass of the hammer into a motion of the molecules of the iron in the nail by friction among themselves; though, at the same time, a certain amount of heat, or rather of temperature, is also developed in the iron by the compression of the mass, and the consequent change of latent heat into sensible.

But, theoretically, we can separate the ideas of the thermic phenomena due to the combined action of friction and compression. And if, in conceiving of the increase of temperature caused by the compression of a given mass of vapour or gas, we exclude the idea of molecular friction, and imagine the rise of temperature to be caused merely by the diminution of volume of the elastic fluid, we cannot perceive that the rise of temperature is entirely due to a change of latent heat into sensible, the total quantity of thermometric heat in the mass remaining exactly the same.

It must, therefore, be admitted that compression, apart from the idea of molecular friction, is not a direct source of thermometric heat, at least in elastic fluids.

Too ready to generalise, and anxious to explain thermodynamical phenomena by a few apparently simple laws, some of our most intelligent engineers seem to have adopted the idea that friction and compression in bodies are only different forms of one and the same phenomenon. The recent words of a high engineering authority are:—"Mechanical force, if expended in compressing bodies, or in friction, which is only the violent mutual compressions of the superficial particles of the bodies rubbed together, produces heat." Whatever meaning may be attached to these words, I submit that a correct theory of thermodynamics requires a wide distinction to be made between the heat actually communicated to a body by the conversion of the motion of mass (or their momentum), into molecular motions, and the development of temperature caused by simple compression. In the former case energy has been transferred to the body in the shape of molecular motion, with an actual increase of thermometric heat; in the latter case energy has been also transferred to the body without any increase of themometric heat, but only a concentration of heat in possession, or change of latent heat into sensible, with a rise of temperature.

In winding up a common spring we put energy into it. In what mode the energy is conveyed from our muscles to the substance of the spring we cannot say; and we must explain the phenomena by the recent doctrine of the "transformation of energy." But, without considering too curiously on this difficult subject, it were more to the purpose to give our attention to the active observation and careful examination of the physical facts bearing on the inquiry which come within the cognisance of our senses. What we know of the mechanical condition of the wound up spring is that the transformed, or transferred energy remains stored up in it as tension, or statical force; the disturbed equilibrium of the molecular arrangement of the particles of the body giving it "a capacity to effect changes"—in short, it contains potential, or undeveloped work.

By compressing an elastic fluid we put energy into it without increasing the quantity of heat it contained. The temperature rises with the compression; and if no heat escape in the process, an amount of work will be produced by the expansion of the fluid to its original bulk under moderated pressure, exactly equal to the force expended in the compression. In compression we suppose the tension, or statical force, to be produced by putting a greater number of elastic material particles into a given space, thus disturbing the molecular equilibrium, and winding up the elemental springs.

When the tension of steam in contact with water is increased by the action of fire under a boiler, the effect is produced by compression, a greater number of vapour particles being forced into a given space in the process.

By heating a gas we, equally, put energy into it. If the initial volume be maintained, tension, or statical force is produced; and we imagine this effect to result from an increased intensity of the molecular movements. In this case the substance represents a wound up spring, possessing a capacity to effect changes.

In this phenomenon everything is relative: statical force, or tension results from a constrained state of disturbed equilibrium; and dynamical force, or mechanical work is evolved in restoring the equilibrium of the elemental springs.

The preceding cases show that energy may be put into an elastic fluid, or the fluid may be put into a condition of energy, either by compression without any increase in heat; or by actually increasing the quantity of heat in the body without compression. And it should be particularly remarked that, in both cases, *the amount of sensible heat in the body is increased;* as on this circumstance depends its work-producing power.

It is said, in general terms, that "heat by expanding bodies, is a source of mechanical energy;" but we should carefully inquire in what manner is mechanical work evolved from the energy, or work-producing power.

In a low-pressure steam engine, working by simple condensation without expansion, all the mechanical work is done in the boiler in the act of the change of state of the water to steam; and the dynamical effect obtained from the engine is only this same work in another shape. When steam begins to form in a boiler under ordinary circumstances, without weight on the safety valve, the air is gradually displaced from the space above the water, and its place occupied by low-pressure steam. In this process every cubic foot of steam formed has, in the act of its generation, performed the work of lifting the column of the atmosphere, or about 15lb. × 144 sq. in. = 2160lb. one foot high. When this steam is condensed in the engine it produces an equivalent amount of work either by the fall of the atmospheric column, acting against a moderate resistance, through the same space of one foot of vacuum; or by the unbalanced expansion against a vacuum of the next cubic foot of steam formed, acting on the piston with a force equivalent to the weight of the atmosphere. It is evident that the heat employed in the process of forming the steam has changed from the sensible state in the fire to the latent state in the vapour; and this change of sensible heat to latent—whatever the physical process may be—is the immediate phenomenon which appears to correspond to "the conversion of heat into mechanical work," as the present doctrine of thermodynamics would term it. It is scarcely necessary to remark that the heat passes from the fire to the water in the sensible state.

If, after the steam-space has been filled with steam of atmospheric pressure, the safety valve is loaded, say to two atmospheres, and the fire continues to act on the boiler, the number of vapour particles in the steam-space will go on increasing, until the density of the steam is doubled, and the rising of the safety valve will prevent the further accumulation of vapour atoms in the inclosed space. In this process we may imagine two distinct phenomena to take place: first, sensible heat from the fire becomes latent in forming fresh portions of steam, and, secondly, though simultaneously, latent heat in the steam already existing becomes sensible by the increased pressure which forces it to occupy a smaller space as the tension increases. The result is, that as we raise the temperature and tension of the steam, we increase the quantity of sensible heat in it, weight for weight; or, in other words, its statical energy, or work-producing power. When steam is formed at once of high tension, the temperature is proportionately high, with a corresponding preponderance of sensible heat in the vapour.

By allowing the vapour to expand under moderated resistance, mechanical work is obtained from the expansion. As far as the steam works at full pressure in the cylinder, the phenomena of expansion, and the accompanying change of sensible heat into latent, occur chiefly in the steam-space of the boiler, and may be scarcely appreciable there during the constant action of the fire, being almost simultaneously counteracted by the continual formation of fresh steam. Yet it will be perceived that the change of sensible heat into latent is still the immediate phenomenon which corresponds to the so-called "change of heat into mechanical work." When the steam works expansively in the cylinder, its sensible heat, during the full-pressure portion of the stroke, may be considered as so much potential, or undeveloped dynamical force, which evolves available mechanical work in proportion as the steam expands after it is cut off, and while its sensible heat becomes latent in the act of expansion. And, here again, we perceive that the change of sensible heat into latent is the exponent of the extra work done by expansion in the cylinder after its connection with the boiler is cut off.

In the foregoing phenomena of practical thermodynamics we do not perceive anything like a direct "conversion of heat into mechanical work." The work is performed in all cases by expansion, or unwinding of the elemental springs, with change of sensible heat into latent; and as regards the quantity of thermometric heat or the total amount of molecular motion in the elastic fluid, it is, theoretically, as great in the exhaust steam after the work is done (or in the condenser water), diffused and of lower temperature, as it was originally in the steam as it entered the cylinder with higher tension and temperature. Independently of theoretical considerations, very numerous experiments made by me on the actual working of steam engines have proved this fact as nearly as the nature of the phenomena will permit; and my results are corroborated by those of Seguin and other intelligent experimenters. Hence I have been reluctantly forced to believe that the present doctrine of thermodynamics is founded on incorrect principles, and therefore requires serious modifications before it will satisfactorily apply to the working of heat engines.

In the case of heating a liquid by molecular friction we certainly perceive that mechanical energy is a direct source of heat; but Rankine says—*Manual of Steam Engine*, &c., p. 300—"The production of heat by friction is distinguished from its production by other mechanical means, such as the compression of gases, in being irreversible; that is to say, it is impossible to make heat produce mechanical energy by any such means as *reversing the process of friction.*" It is not a little strange that, with this obvious fact in view, such an intellect as Rankine's should not perceive that the direct mutual and reciprocal convertibility of heat and mechanical work is, on the very face of the inquiry, problematical; and if the reasoning which I have above adduced be allowed to prove that compression (apart from the idea of molecular friction) is not a direct source of heat, but only of temperature, the conviction forces itself upon us that thermometric heat is not a direct and immediate source of mechanical work, but rather a mediate condition of matter which, by disturbing molecular equilibrium, causes or permits a winding up of the elemental springs in a manner as yet mysterious to us. We may form some idea of a development of potential energy already held by the fluid in latent possession, in some way unknown to us; or an equally inexplicable appropriation of energy by the fluid from some universally diffused etherial source, by which the mass, while under the influence of sensible heat or temperature, acquires a capacity to perform work. But, however this may be, we perceive that an energy, or work-performing force, does exist in the hot fluid beyond what can be accounted for by the mechanical theory of heat. We must therefore boldly meet the question—what or whence this energy? I think no satisfactory answer can be given in the present state of our knowledge; but we may hope that science, properly applied, will soon clear up the mystery. Meanwhile let facts be severely scrutinized as far as our knowledge extends; and if any points of obvious error be detected in current doctrines, let them be at once sacrificed to truth.

I have had occasion to remark elsewhere that:—"High-pressure steam contains more mechanical energy than steam of low-pressure, weight for weight, though the quantities of thermometric heat are equal, or nearly so, in both cases; and *we are compelled to look for the source of this excess of energy elsewhere than in the mere molecular result of matter and motion supposed to constitute the steam, and calculated by the usual laws of mechanics.*" Whence this excess of energy in high-pressure steam as compared with steam of low-pressure? It is right that the argument be met, and fairly confronted; and I again appeal to our scientific authorities for a candid investigation of the subject.

JOSEPH GILL.

Palermo, October, 1862.

The South African Irrigation and Investment Company has been announced. The objects of the directors are threefold, viz., to purchase lands with a view to resale after the construction of irrigation works, and to enter into contracts for similar works upon Government and private lands; to undertake the lighting, paving, and supply of water in the several towns; and to carry on the business of a trust, loan, and investment company. The nominal capital is to be £1,000,000, in £50 shares; the first issue to consist of 10,000.

REVIEWS AND NOTICES OF NEW BOOKS.

The following valuable works have been received by us, too late for a notice in our present issue, but will be reviewed in our next, viz.:—

Mathematics for Practical Men: Being a commonplace book of pure and mixed mathematics. Designed chiefly for the use of Civil Engineers. Architects, and Surveyors. By Dr. Olinthus Gregory, LL.D., F.R.A.S.; enlarged by H. Law, C.E. Fourth Edition. London: Lockwood & Co, 1862.

Electrical Accumulation and Conduction. By F. C. Webb, Associate Inst. Civil Engineers. Part I. London: E. & F. N. Spon. 1862.

NOTICES TO CORRESPONDENTS.

J.W.—1. We have not the detailed information you seek upon this point. We believe, however, that the chief engineer has diagrams of the performance from Liverpool to Woolwich, when, if we remember rightly, the vessel made some $14\frac{1}{4}$ knots per hour. You will have no difficulty in getting the particulars from the chief engineer. 2. We can only repeat our previous answer as to this, and regret to find that any one, unauthorised by you to use your name, should thus have intruded upon us. There surely must be some misunderstanding on the part of your representative. 3. As to this question, we had prepared you a detailed reply, presuming you referred to a *screw propeller.* Your postscript, however, renders it necessary that we defer our reply till our next issue, when we will give you the necessary data.

T.P. (New York).—We do trust that your health will soon be sufficiently improved to enable you to complete the article. We have been anxiously expecting to hear from you for some time back.

ENGINEER.—We prefer the water meter patented by Mr. H. Frost, and manufactured by the Manchester Water Meter Company. The internal diameter of inlet and outlet pipe of meter for 25 to 60 horse-power boiler, should be $\frac{3}{4}$ in.

C. H.—Since we wrote you, it has occurred to us to refer you to the second volume of Isherwood's *Engineering Precedents.* Mr. Isherwood has, from numerous experiments, determined the drag per square foot of wetted propeller surface, at a velocity of 10 feet per second, and by dividing the blade into elementary parts, and supposing the drag to be as the square of the velocity, he sums up the loss of the propeller *per se.*

J. S.—Mr. Alexander Allan, of Perth, read a description of the Feed-pipe connection, to which you refer, at a late meeting of the Institution of Mechanical Engineers. It appears, from Mr. Allan's paper, that this connexion has been fitted to a number of locomotives on the Scottish Central Railway, including some large goods engines; and it has been subjected to severe tests during the last twelve months, and has given every satisfaction. In the engines on this railway the plan of coupling between the engine and tender, drawing as well as buffing on a heavy laminated spring, allows more movement than is usual, amounting to a play of 2in. between the engine and tender, and the connecting tube is 6in. out of the centre; but even under these conditions no failure of the connecting tube has occurred. The dimensions of the engine to which it has been longest attached are: diameter of cylinder 16in.; stroke 20in.; driving wheel, 6ft. diameter; steam pressure in boiler, 130lbs. per square inch, and boiler supplied with No. 9 injector; and the connecting tube has now been continuously working upon this engine for nearly twelve months with complete success, the engine having run about 20,000 miles during the time. This tube, which had been taken off the engine, was exhibited to the meeting: it was of circular section, and simply secured with soft solder, and there did not appear to be the slightest sign of its giving way, showing that it was fully equal to its work. A specimen was also exhibited of a connecting tube of oval section, used on large coupled engines: in its manufacture the tube is swaged oval in proper cresses, and is then filled with resin, and coiled to the required circle round the cast iron blocks used for blocking tyres.

SAUCER DOCK.—We some time since received the following letter from an anonymous correspondent, and now publish the letter; as we have lately had several inquiries made to us upon the same subject.

I have been asked my opinion respecting the Saucer Dock, now being adopted at the Victoria Docks, with reference to the following particulars:—

1st. Is it a judicious outlay of capital?

2nd. Will a ship be safe upon it, and the machine and ship not be likely to upset together?

3rd. Is it likely to be worked satisfactorily?

1st. It does not appear to be a judicious outlay of capital, because the same amount of capital would provide simpler and better means for getting at ships' bottoms in order to repair them. But the great objection to the plan as a monetary investment appears to be this. It will be principally used to enable shipowners to do *small* repairs to their ships, and no *remunerative* charge can be made that shipowners will pay. If large repairs be required to a ship, the expense of taking materials to the ship will more than counterbalance the expense of transporting the ship to the dry docks in the river. And a shipowner employing a shipwright would very much prefer putting his ship into such shipwrights' hands in his own establishment where the materials, kilns, saw-pits, smith's shop, joiner's shop, and every appliance belong to the shipwright himself, to merely having the superintendence of such shipwright at the Victoria Docks, he having to send for officers, men, materials, &c., as they were required. The *private* docks recently established at Birkenhead are preferred by shipowners to the Corporation Docks at Liverpool, although ships have to be removed from the corporation "wet docks," and transported across the Mersey to get at those private docks.

2nd. A ship will be in no danger of upsetting from the want of stability in the machine. The "Saucer Dock" is to be a rectangular tank, about 400ft. long and 60ft. broad, having an immersion of about 4ft. depth. This affords abundant stability. For according to Leslie, $\frac{60^2}{4 \times 12} = 75$ft., the *meta centre;* and the centre of gravity of the whole mass of tank and superincumbent ship will never perhaps be more than from 10 to 20ft. above the centre of buoyancy of the tank or "saucer."

3rd. I have considerable doubt as to its working satisfactorily. The cylinders, cross-heads, connecting-rods, girders, &c., form a very simple machine; and if the ship be so placed as to equalize the strain upon all the girders, it will be an easy matter to lift her out of the water as far as the machine is concerned. But I think Mr. White's letter, stating objections to the plan, to be well worth consideration. And it strikes me that as a pressure of 2000 tons will be exerted upon little more than a line under the ship's keel, in the middle of the "saucer," the pressure of the water upwards with a leverage of 30ft. (or more properly $30 \times \frac{2}{3}$) on each side will be likely to distort its form, and damage both ship and "saucer" unless effectual means be employed to secure extraordinary rigidity. There will be considerable difficulty in adapting the centred cradles to the form of the various bottoms that may have to rest upon them, and I have not yet heard any plan of *shoring* the ship proposed that would be without considerable difficulty, and perhaps some danger both to ship and saucer. This may be surmounted, but certainly not without constant trouble and expense. But, it seems to me, that the greatest difficulty will arise from transporting the ship and saucer, when the former is sustained by the latter, from between the hydraulic cylinders to the recess cut in the margin of the basin for their reception. I contemplate with fear a large ship uplifted entirely out of the water upon a tank with only 4ft. depth immersion, exposed to the action of a high wind in such an exposed place as the Victoria Docks. When I know that on windy days the most experienced men refuse to take charge of a large ship afloat, although only to move her from one side of the river to the other, I cannot help thinking that "saucer" and ship, exposed as they will be, must be very frequently unmanageable by any manual or other power likely to be provided.

G. J. Y.

J. P.—*Du Trembley Combined Vapour Engine.*—We are unable to inform you what has become of the three ships fitted with the ether apparatus. If we recollect rightly, they were named the *France*, the *Brazil*, and the *Du Trembley.* There were also some five or six vessels, three being 150 nominal horse-power, and the others of 400 nominal horse-power, which were intended for the African and Brazil trade, these were in 1856 in course of construction in France, and were built for a French Company

O.—The subject you refer to was included in a paper read by Mr. J. Grantham, C.E., at a meeting of the Royal United Service Institution, "On the Protection of the Bottoms of Iron Ships from Concussions and from Foulings, and we will now let Mr. Grantham speak for himself:—"I commence by attaching frames to the outside of the vessel to run up to the light water-line, or to the armour-plates in large plate-clad ships. These frames are rolled like common angle iron, except that the outside edge is made of a wedge form, or flanged; they are rivetted to the ship in the usual manner. Between these is driven a timber planking, which becomes firmly wedged; and being set in with suitable compositions, and then caulked, forms a solid bed. This would be made from refuse timber cut from the wood used in the other parts of the ship. The whole being then dubbed even with the ribs, and again coated, another sheathing is attached by brass screws. I have made the inner one for large ships four inches thick, and the outer one two inches. The copper sheathing is then attached in the usual way. Thus a firm substantial bed is prepared for the copper, all metallic contact is avoided, and great additional protection is given to the bottom of the vessel. I will endeavour now to anticipate and reply to the objections that may be used against this system. 1st. That it will be expensive. 2nd. That it will add to the weight of the vessel. 3rd. That it will injure the iron plates. 4th. that the timber work will become loose when the vessel strains. 1st. As regards the expense. I estimate the timber, labour, screws, and coating at less than £4000, if put on when the ship is building, on a ship valued at £350,00. The copper is not included. I claim against this, in making a ship of equal safety, a saving of 200 tons of iron, which, at £20 per ton, equals £4000. But by far the largest set-off is to be found in the saving of steam-power, and for foreign service, I set this down in the *Warrior* at 500 horses, upon the average of a three years' cruise in warm climates, or 200 horses in the home service; or what is more important still, that the vessel shall, if kept clean, at all times maintain her proper speed. 2nd. If the comparison is to be fairly carried out, the increase of weight will be very little. I claim a saving of 200 tons of iron, and the timber will weigh 280 tons, a difference of 80 tons in a vessel displacing 8000 to 9000 tons. I deny that it will injure the plates; on the contrary, I assert that it will be a great protection to them, for being once well painted, the sheathing will effectually protect the paint, and while this remains unbroken, there is no fear of corrosion. There being no bolts to work loose, and no metallic contact, there is abundant evidence so show that the plates of iron ships, under such circumstances, will be entirely free from injury.

D. R.—1. The subject of the first portion of your communication shall receive our best attention, and a reply be sent to you. 2. As to the locomotive, we are much interested by the brief description you have sent us, and should like to see drawings of the model referred to. Advise us of the change of your address should you leave, as anticipated.

R. B.—We will send you the particulars as to examination, and a selection of the best works of reference, with a view to your qualifying yourself.

R. T.—Received with thanks, but too late for insertion.

R. W.—Thanks for your contribution, which we have used, as you will perceive, in the present number.

RECENT LEGAL DECISIONS
AFFECTING THE ARTS, MANUFACTURES, INVENTIONS, &c.

UNDER this heading we propose giving a succinct summary of such decisions and other proceedings of the Courts of Law, during the preceding month, as may have a distinct and practical bearing on the various departments treated of in our Journal: selecting those cases only which offer some point either of novelty, or of useful application to the manufacturer, the inventor, or the usually—in the intelligence of law matters, at least —less experienced artizan. With this object in view, we shall endeavour, as much as possible, to divest our remarks of all legal technicalities, and to present the substance of those decisions to our readers in a plain, familiar, and intelligible shape.

HILL *v.* THE LIVERPOOL UNITED GAS COMPANY.—The Lord Chancellor gave judgment in this case, wherein the plaintiff alleged that the defendants had infringed his patent for the purification of gas. His lordship said the first question he had to decide was whether the application by the defendants in the purification of gas of a certain natural substance called bog ochre was or was not an infringement of the plaintiff's patent. The plaintiff affirmed that it contained a large quantity of precipitated oxide of iron, and that the application of precipitated oxide of iron from any source, natural or artificial, pure or combined with other substances, was a violation of his patent. The defendants denied that the material in question contained precipitated oxide of iron but if it did, they insisted that it was latent or natural, and not artificial; and they contended that, according to the true construction of the plaintiff's specification, the specification was limited to the application of such oxides only as were prepared by some artificial means. Another court, in a previous case, had already decided that the specification was thus limited; and in accordance with that decision, this Court would refuse to grant an injunction restraining the defendants from using bog ochre in the purification of gas. But a more material question still remained, viz., were the defendants to be permitted to use that substance in an artificial state in the purification of gas? They admitted that when the bog ochre in its natural state had been so long used as to become inert, it was revivified and restored by using the process described in the plaintiff's specification. The user of the bog ochre in that artificial state was an infringement of the plaintiff's patent. There would be a decree to the effect that the use by the defendants of bog ochre in the purification of gas, so long as the same was in its native state, was not an infringement of the plaintiff's patent, but that the use by them of that substance when restored by the process described in the plaintiff's specification was an infringement, and ought to be restrained. There would be the usual accounts of the profits earned by the defendants using the bog ochre when in an artificial state, but there would be no costs on either side. Mr. Druce for the defendants, asked for some delay in the the enforcement of the injunction, because they supplied a large portion of the inhabitants of Liverpool with gas, and some time would be required to make the alterations occasioned by the decree. The Lord Chancellor allowed the defendants two months to prepare for the enforcement of the injunction.

RUSSELL *v.* BANDIERA.—This was a special case, in the Court of Common Pleas, for the consideration of the Court. The plaintiff brought an action against the defendant at the representation of the Portuguese Government to recover £10,400 upon a contract for the building of a steam vessel of war for that Government in his yard. The action was tried before Mr. Justice Wightman in 1860, at the Surrey assizes, when the matter at issue was turned into a special cause, and a verdict was taken for the plaintiff. The questions for consideration were, first, whether the plaintiff was entitled to recover in respect to all or any of the different classes in certain accounts rendered; and, secondly, what amount of penalties the defendant was entitled to set off against the plaintiff's claim. If the Court thought the plaintiff was not entitled to recover in respect to the said charges, then the verdict was to be set aside and entered for the defendant. The Lord Chief Justice said there appeared to be three substantial questions submitted for the consideration of the Court. The first related to the value of articles supplied by the plaintiff under his contract for building the ship in question during the time that the contract was in the course of performance. The second was with respect to what he (the Lord Chief Justice) would call "warlike equipments" for the purpose of classification, which he should consider, under the circumstances of this case, were supplied after the ship was complete and delivered. And the third had reference to the value of goods supplied by Mr. Scott Russell after he had entirely performed his contract and delivered the ship; and then it was "value ordered and delivered to and received by the defendant and accepted." With regard to this last question the facts of the case clearly showed that the amount sued for under this head—namely, £116—was for value supplied after the ship had been delivered up to the defendant under the contract, and consequently that the plaintiff was entitled to that sum. With respect to the question whether the plaintiff was by his contract obliged to supply warlike stores to the steamship in question, the ship was built at the plaintiff's yard in accordance with the terms upon which ships of her Majesty's navy were built in private yards, and it was to be "finished, fitted, found, and equipped," in accordance with these terms, and that it was so to be delivered to the Portuguese Government. He was of opinion that the plaintiff was not obliged to supply the stores in question, and as he did supply them, at the request of the defendant's solicitor, he was clearly entitled to his claim in respect of them for £2000. Then, as to the claim of the plaintiff against the defendant in respect of certain alterations and additions made in the fitting of the ship, the plaintiff had no claim against the defendant for them. It was next alleged by the defendant that the plaintiff was liable for penalties for not having handed over the ship within a specified time; but it was found that the delay which had taken place in this respect was caused by the acts of the Portuguese government, and not by the neglect of the plaintiff; consequently the plaintiff was not liable under the terms of the contract. The judgment of the Court would therefore be in favour of the plaintiff. The other learned judges concurred with the opinions of the Lord Chief Justice.

NOTES AND NOVELTIES.

OUR "NOTES AND NOVELTIES" DEPARTMENT.—A SUGGESTION TO OUR READERS.

We have received many letters from correspondents, both at home and abroad, thanking us for that portion of this Journal in which, under the title of "Notes and Novelties," we present our readers with an epitome of such of the "events of the month preceding" as may in some way affect their interests, so far as their interests are connected with any of the subjects upon which this Journal treats. This epitome, in its preparation, necessitates the expenditure of much time and labour; and as we desire to make it as perfect as possible, more especially with a view of benefiting those of our engineering brethren who reside abroad, we venture to make a suggestion to our subscribers, from which, if acted upon, we shall derive considerable assistance. It is to the effect that we shall be happy to receive local news of interest from all who have the leisure to collect and forward it to us. Those who cannot afford the time to do this would greatly assist our efforts by sending us local newspapers containing articles on, or notices of, any facts connected with Railways, Telegraphs, Harbours, Docks, Canals, Bridges, Military Engineering, Marine Engineering, Shipbuilding, Boilers, Furnaces, Smoke Prevention, Chemistry as applied to the Industrial Arts (for which we are chiefly indebted to the *Chemical News*), Gas and Water Works, Mining, Metallurgy, &c. To save time, all communications for this department should be addressed "19, Salisbury-street, Adelphi London, W.C." and be forwarded, *as early in the month as possible*, to the Editor.

MISCELLANEOUS.

LONG STEAM PIPE.—At the Kirkless Hall Colliery, near Wigan, the boilers are above ground, and the engine in the working below. Steam is carried to a total distance of 1400 yards, fires being employed along the pipe to re-evaporate the steam condensed in its lengthy passage.

PORTABLE SHIPS' ENGINE-PUMPS.—A trial of three rival portable ship's engine pumps, took place at Woolwich Dockyard, by order of the Admiralty on the 6th ult. The first engine tried was that of Mr. Roberts, of Millwall, manufactured by Messrs. Brown, Lennox, and Co. This was a double action pillar-pump, and was worked by four men, and afterwards by double that number, casting various jets of the water, by a change of hose-pipes, directed horizontally and vertically. It filled a tank containing 108 gallons of water in 2 minutes and 31 seconds, from one of the fitted basins adjoining the place of trial. The result was very satisfactory. The next trial was with Mr. Stone's of Deptford, also a portable engine of similar dimensions, but pronounced superior in power and capacity in each of the tests, as to distance, height, and time consumed in filling the tank. The third engine was that of Mr. Gossage, and manufactured by Mr. Stone, which underwent the same series of trials as the two above named, and with a slight advantage over that of Mr. Roberts. At the termination of the trials an opinion was pronounced in favour of the engine supplied by Mr. Stone.

WATERPROOF GLASS ROOFS.—Messrs. Showell, of Manchester, have taken out a patent for waterproof glass roofs, recommended as especially applicable to railway stations and horticultural buildings. The invention consists of plates of glass, with the edges only turned up; and where they meet one another, protected by a metal cover. The top edge of the glass rests upon a horizontal flange L iron purlin, and the bottom edge on the edge of the vertical flange; so that the top edge of the glass is overlapped by the bottom edge of the plate above. A screw bolt passes through the bottom end of one cover between the two adjacent plates of glass under this cover, and is then secured through the horizontal flange of the L iron purlin. A pin passes through the sides of the bottom end of the covers, and prevents the glass plates from slipping down, by catching their turned-up edges. There is a further improvement, in which the top and bottom edges of the plates of glass are turned, the one up and the other down. In this form a more secure joint is effected at the top and bottom edges of the glass, and with a less lap. The top end of each cover prevents the glass plate next above it from slipping down, by catching its turned down edge, and no pin is required. By this new form of construction no putty is needed in the joints; and expansion and construction, or any other slight movement, can go on without impairing the waterproof construction.

PARAFFIN.—Cannel coal is the source yielding the largest amount of paraffin. The paraffin oil is the heaviest which passes over from a still in the distillation of coal-tars—its specific gravity ranging from 900 to 930. It is placed in a vat and cooled down with ice or other refrigerating agents, when it crystallizes in large scales. It is then lifted and strained, placed in bags, and submitted cold, to severe pressure. It is then remelted, and treated with half its weight of strong sulphuric acid, at a temperature of 356° Fah. The acid removes any impurities, consisting of bitumen, that may be in it, after which it is washed with water, run into cakes, and pressed again while warm, in a hydraulic press. It is again melted and treated with caustic potash in solution (some use alcohol) to remove any resinous matter that may be left, after which it becomes as clear as water before solidification. It is now admitted that there are several varieties of paraffin, but there is little to distinguish them excepting their melting points, which range from 113° up to 139° Fah. Aniline colours impart to paraffin candles most beautiful red, purple, and violet tints.

Manufacture of Saltpetre.—Saltpetre is obtained in the Mammoth Cave, Kentucky, and considerable quantities were obtained from this source during the war of 1812. It is derived chiefly from the excrements of bats, &c. Most of the saltpetre which is employed for the manufacture of our gunpowder comes from India. It is not known whether any saltpetre is now obtained from natural sources in the Southern States. If the Secessionists were deprived of this substance entirely, they could not carry on a war. The nitrate of soda is very abundant in many parts of the world, and were it not so deliquescent, it would answer just as well for making gunpowder as nitrate of potash. The formation of natural saltpetre is a very slow process, requiring about two years to complete. During the French Revolution 2000 tons were made in one year in Paris; and were foreign supplies cut off, twice this quantity could be made in the same space of time in the city of New York with its present number of inhabitants. In Sweden, each peasant who owns a house is bound by law to make a certain quantity of saltpetre every year for the use of the State. In Spain, Egypt, Persia, and especially India, vast quantities of this salt are made annually; and it is not only a source of great profit, but of warlike power to Great Britain.

Improvements in Artificial Light.—An improved light, which promises to render the production of the lime light so economic that it may be brought into general use, was exhibited before the Executive Committee during the recent fair of the New York State Agricultural Society, and gained for the inventor, Dr. George H. Smith, of Rochester (U.S.), the society's silver medal. In place of hydrogen he employs ordinary coal gas, and instead of oxygen atmospheric air, which he states decomposes at the moment of combustion by passing through a suitable burner. The cost of the light, which is described as equal to the oxy-hydrogen light, does not exceed ½*d*. per hour. The character of the light may be judged of from the fact that photographs have been taken with it, and the apparatus is said to be durable, and more easy of control, than an oil lamp. The new light is considered to be thoroughly applicable for locomotive and ships' lights, as well as for lighting streets, churches, halls, and private rooms.

NAVAL ENGINEERING.

The American Turret Battery Paissac.—New York papers recently received contain an account of the trial of this vessel, built on the plan of the *Monitor*, carrying two guns in her turret—one of 11in., and the other of 15in. bore—the latter being the largest piece of ordnance that has yet been mounted on board any vessel. The following are the dimensions of the *Paissac's* monster gun:—*maximum* diameter, 48in.; *minimum* ditto (rough), 38in.; *minimum* ditto (finished), 26½in.; bore, 15in. The length of the gun is 13ft. 7in.; the weight of rough casting, 68,000lbs.; of the finished gun, 42,000lbs.; of the solid shot, 460lbs.; and of the shell, 330lbs. The *maximum* or service charge of powder is 35lb. The speed attained by the *Paissac* on her trial trip was only five knots.

Iron-cased Steam-Vessels for Turkey.—Mr. Napier, the eminent shipbuilder of Glasgow, has received an order from the Turkish Government to construct three iron plated screw frigates of the *Warrior* class, at a total cost of about £750,000 sterling. The machinery of these vessels will be made by the same firm, and is included in the contract.

Naval Appointments.—The following have taken place since our last:—G. S. Cornish acting Second-class Assist. Engineer to the *Indus*, for the *Shais;* J. R. Stuart, of the *Odin;* W. H. Kent, of the *Magicienne*, C. Boddington, of the *St. George*, and R. Hall, of the *Asia*, confirmed as Second-class Assist. Engineers: J. Driver, in the *Asia*, promoted to Chief Engineer; T. Hall, in the *Fisgard*, promoted to be Chief Engineer; W. Gilbert, Second-class Assist. Engineer, to the *Eclipse;* J. R. Beal, J. Radford, J. Sharpe, P. McCormack, B. F. Leward, W. C. Amos, E. Fisher, T. Andrews, and W. H. Moore, Supernumaries in the *Euryalus*, confirmed as Second-class Assist Engineers; W. Lewther, Chief Engineer, transferred from the *Fisgard*, to the *Cumberland*, for charge of the *Prometheus;* S. H. Dawkin, late of the *Kestrel*, promoted to acting Engineer; W. G. F. Coltey, acting Second-class Assist. Engineers to the *Asia*, for the *Duncan;* W. E. Pilcher, and R. Glasspole, of the *Neptune*, V. Horn, of the *Emerald*, and C. D. Thomas of the *Scout*, promoted to First-class Assist. Engineers; H. White (a) of the *Flying Fish*, J. Murray, of the *Indus*, J. Croll, of the *Arrogant*, W. Bowen, of the *Scylla*, and H. J. Iles, of the *Reynard*, promoted to acting First-class Assist. Engineers; E. C. Leigh, Second-class Assist. Engineer to the *Dauntless*, for *Tender;* A. Stewart (b), G. B. Blackwell, and G. J. Maybury, Second-class Assist. Engineers, and J. H. Lankester, and J. Mitchell, acting Second-class Assist. Engineers to the *Nile* as Supernumaries; R. Glow, Chief Engineer to the *Cumberland*, for the *Hero;* G. Mills, Engineer to the *Lily;* F. Brockton, Engineer to the *Cumberland*, for the *Vigilant;* C. Jackman, and S. Booth acting First-class Assist. Engineers, and J. Jenkins, acting Second-class Assist. Engineer, to the *Lily;* W. P. Davis, acting Second-class Assist. Engineer, to the *Sutlez*, as Supernumary; W. J. Ibbett, Chief Engineer, to the *Asia* for the *Urgent;* G. C. Scholes, in the *Barracouta*, promoted to Acting Engineer; T. J. Sweeney, First-class Assist. Engineer to the *Fisgard*, as supernumerary; R. Ditchburn, First-class Assist. Engineer, to the *Asia*, for the *Albacore;* J. F. Channon, Engineer, to the *Indus*, for the *Ferret;* W. White, Second-class Assist. Engineer, to the *Cumberland*, as supernumerary; G. Aitcheson, Chief Engineer, to the *Meeanee;* J. J. Blunden, Engineer, W. C. Catty, acting First-class Assist. Engineer, T. Griffiths, acting Second-class Assist. Engineer (for temporary service), and H. Burstow, Second-class Assist. Engineer, to the *Meeanee;* D. A. Campbell, First-class Assist. Engineer, to the *Cumberland*, for the *Carnation*.

MILITARY ENGINEERING

Blakely's Guns.—Forty cast iron guns, strengthened on Captain Blakely's principle of wrought iron hoops shrunk on over the breech, and rifled according to Commander Scott's system, by order of his Highness the Viceroy of Egypt, have been thoroughly tested at the Arsenal butt, Woolwich, and, having passed proof, have been sighted in the Royal Gun Factories, and completed. They have been despatched to Alexandria for the service of the Egyptian artillery; an additional number of guns, on the same principle, have been fired at the Royal Arsenal butt, with a heavy charge of powder and shot, having been purchased by the Pasha on the usual conditions.

Exports of Arms and Ammunition.—Twelve million, four hundred and forty-seven thousand, six hundred and twenty-seven pounds weight of gunpowder were shipped for exportation to various countries from the United Kingdom, in the first three quarters of the present year. In the same period of 1861, the quantity was not so great by 4½ million pounds. Directly or indirectly, the greater part of this increase has, without doubt, found its way to the United States of America. The number of rifles, revolvers, and other small arms exported in the first nine months of this year was 459,000, whilst in 1861 it did not amount to 168,000. In the following table are given the values of all fire-arms and gunpowder exported in the first three quarters of the years 1861 and 1862, showing the increases that have occurred:—

For the Nine Months Ended September 30.

Arms, Ammunition, &c., viz.:—	1861.	1862.	Increase.
Fire-arms, small	246,092	941,619	695,527
Gunpowder	240,292	371,757	131,465
Of all other sorts, except lead shot	121,729	150,239	28,510
Totals	£608,113	£1,463,615	£855,502
		608,113	
Increase in 1862 over 1861		£855,502	

STEAM SHIPPING.

Double Screw Steamer.—The *Flora*, of 400 tons, double screw propeller, was built at Blackwall, from designs by Mr. Dudgeon, and on the 7th ult., an official trial of her speed and capabilities of manœuvring took place upon the river between Tilbury and the Mouse Light. The dimensions of the *Flora* are as follows:—Length on load line, 150ft.; beam, 22ft. 6in.; depth in hold, 13ft. 6in.; nominal horse-power, 120; indicated horse-power, 400; two screws of three blades each, 7ft. in diameter, and having a pitch of 14ft. 6in. On the day of trial she drew 7ft. water aft and 5ft. 5in. forward. Her displacement was 350 tons, and the area of immersed midships section 130ft. She is rigged as a fore and aft polacca-masted schooner; her masts fitted with joints near the deck, so that they can be lowered down should occasion require it; she is also fitted with a telescope funnel. Immediately after leaving Tilbury-wharf she was put to a severe test by steering a course in the form of the letter S through a fleet of shipping that lay at anchor off Gravesend, and the manner in which she steered was most satisfactory. She then proceeded at moderate speed to the Nore Light, working at 15lb. pressure, at a speed to the vessel of 10·6 knots, of the screw, 14·5, with two knots of flood tide against her, and an estimated slip of two knots—making an average of 12 knots an hour. She was abreast of the Nore at 1h. 55m. 25s., just at high water, and then proceeded on her trial to the Mouse Light-vessel, 7¾ nautical miles distant. In the middle of the trial she was working at 18lb. pressure, and the screws making 106 revolutions per minute; her engines, also made by Mr. Dudgeon, worked beautifully. The Mouse Light was reached at 2h. 27m. 6s., exactly in 31 minutes 43 seconds. She left the Mouse Light for the Nore at 2h. 29m. 28s., and reached the latter at 3h. 18m. 14s.; she was 15 minutes detained on this passage by the port engine bearing getting heated, which would leave her passage up, against the first of ebb, at 34 minutes; an average of 14 nautical miles per hour from a new vessel. After leaving the Nore, on her passage up the river, she was subjected to the following trials:—1st trial. Turning ahead with both engines full speed, then taking a bearing from the shore, putting the helm hard over, and noting the time she took to describe a circle—three trials. Mean time occupied in describing the circle, 3 minutes 13 seconds. 2nd trial.—Keeping a course of full speed, then easing and stopping one screw, keeping the other at full speed, the helm then being put hard over to note the time she took in describing a circle. Time occupied, 3 minutes 26 seconds. 3rd trial.—On a course at full speed, then backing one screw astern full speed, keeping the other at full speed ahead, with the helm hard over to see what time she would take in describing a circle. Time occupied, 2 minutes 34 seconds. 4th trial.—Stopping both engines and screws; starting from a state of rest; turning one screw ahead full speed and the other screw astern full speed, noting the time she took to desscribe a circle. Time occupied, 4 minutes 2 seconds. We may add, that with reference to the application of double screw propellers, considerable credit is due to Commander Symonds, R.N., who has very ably demonstrated the advantages possessed by the double over the single screw propeller, and worked by independent engines; the joint invention of Commander Symonds and that useful member of the engineering profession, Mr. Richard Roberts.

Steam Shipbuilding on the Clyde.—Messrs. Burn have contracted with Messrs. Caird and Co., of Greenock, for two paddle steamers for the Royal Mail line between Glasgow and Belfast. Messrs. Napier are also occupied with a paddle for the same line. Messrs. L. Hill and Co. have lately launched at Greenock a screw of 600 tons, built for the Calcutta and Burmah Steam Navigation Company. The vessel has been named the *Bussoral*, and is being engined by Messrs. A. and I. Inglis. Messrs. W. Denny and Bros. have contracted to build for the Spanish Mail service, through Messrs. A. Lopez and Co., of Alicante, a duplicate of the large and powerful vessel arranged for some time since. The steamers will be each of 2000 tons burden, and will have 500 horse engines. Mr. A. Denny is also under a contract to build a screw steamer for the Spanish coasting trade. The King of Burmah has ordered two powerful river steamers, as well as a sea-going steamer, which is to ply in the Bay of Bengal. The contract has been taken by Messrs. A. and I. Inglis, through Messrs. Halliday and Co., of Rangoon.

The "City of Melbourne," built by Messrs. J. and G. Thomson for the Australasian Steam Navigation Company, attained on her trial trip a speed of 13 knots per hour; her burden is 900 tons builders' measurement, and she is 250ft. long, by 28ft. beam, and 17ft. deep, being fitted with a pair of four-piston-rod geared engines.

LAUNCHES OF STEAMERS.

Launch of the "Poonah."—On the 8th ult., the Peninsular and Oriental Company's new iron steam ship *Poonah* was launched from the dockyard of the Thames Iron works and Shipbuilding Company. The length of this vessel between the perpendiculars is 315 feet, her extreme breadth, 41ft.; her depth of hold, 30ft.; her length of keel for tonnage, 290ft. 5in.; and she is 2597 tons burden. Her engines are by Humphreys and Tennant, and are of 500-horse power, but are not yet on board. The ship has been built with a view to secure with great speed the most perfect accommodation for goods and passengers, and she unquestionably forms a magnificent addition to the already numerous and powerful fleet of the Peninsular and Oriental Company. This vessel was designed by Mr. Ash, who has had the satisfaction of designing several of the largest ships now afloat, but who has resigned his appointment in connection with this company for the purpose of entering upon business on his own account. At the present moment no less than five iron-cased vessels, of the largest and most formidable class, are being constructed by this firm. First and largest comes the *Minotaur*, an enlarged and improved *Warrior*, and building on the same slip from which that frigate—the first contribution to the reconstruction of the British Navy, and finest ship of war in the world—was launched. The *Minotaur* is 400ft. long, 59ft. 4in. broad, and nearly 7000 tons burden. She will be protected from stem to stern, differing in this respect from the *Warrior* (which only carries her armour amidships), and will be defended by 9in. of teak and armour plates of 5½in. thick, an inch thicker than those of the Warrior. The company are also building for the British Admiralty another iron-cased frigate, the *Valiant*, of 4100 tons burden, which will be launched in the spring of next year. Her protecting armour is similar to that of the *Warrior*, viz., 18in. of teak and 4½in. armour plates. In an advanced state of progress is also a floating battery for the Russian government, 220ft. in length, 53ft. broad, and 2800 tons, also protected by 4½in. armour plates on 9in. of teak, and intended to carry 26 68-pounder guns on a draught of 14ft. The frames are also beginning to be erected of a frigate which the company have just undertaken to build for the Spanish Government, of about 5000 tons, with 5½in. armour plates; and the slip is also being prepared for a similar frigate of 4300 tons for the Turkish Government, making altogether nearly 23,000 tons of iron-cased shipping under construction by one firm, which together constitute a formidable fleet superior to what is possessed by any but the first-rate naval powers.

Launch of the "Roman."—The launch of this unsinkable, and fire-proof steamer for the Cape mail service, took place on the 10th ult., from Deptford-green Dockyard. The interior fittings of the *Roman*, are very simple, and well worthy the attention of the scientific. Suppose a ship with two or three decks divided in the ordinary way with transverse bulkheads. Should one of these lower bulkheads become filled with water, the bulkhead will fill above and throughout from deck to deck, and the consequence may be that the ship will become unseaworthy. To provide against this a mere watertight trunk-way is carried from each lower deck to the upper deck, so that in the case of water getting into a bulkhead it cannot rise throughout, but can only rise in the watertight trunkway after the unimportant part of the ship has been filled into which the water has gained admission. The *Roman* is the second unsinkable and fire-proof steamer built by Mr. Charles Lungley for the Cape mail service, and the seventh steamer built by him for the Union Company. The dimensions are 260ft. between perpendiculars, and 28ft over all; breadth 32ft. and depth 25ft. The builder's tonnage is 1311 55-94 tons, and the engines are to be of 220 horse-power.

The Elba.—On the 19th ult. this steamer was launched from the yard of Messrs. J. Wigham Richardson and Co. She is intended to carry the mails between Genoa and the Tuscan Archipelago. Her dimensions are 133 feet long, 18½ feet beam, and 11½ feet deep She is fitted up for both first and second class passengers. She will be fitted with engines of 50 nominal horse-power, by Messrs. R. and W. Hawthorn.

RAILWAYS.

The Legal Expenses of Railway Companies.—During the past seven years the Great Western Railway Company has spent £86,000 in legal proceedings, principally in opposing the formation of other lines, and of this £40,000 was absorbed in 1861 alone, and that some of the bills have not yet come in. The South Western has during the same period spent about £60,000 in similar proceedings, and most of the other railway companies have expended sums in a like ratio.

RAILWAY ACCIDENTS.

Accident on the North-Eastern Railway.—A collision occurred on the Richmond branch of the North-Eastern Railway, on the 3rd ult., one person being killed and a number of others seriously injured. Every Monday fortnight a cattle train leaves Richmond for Darlington, to accommodate dealers attending the Darlington market. This cattle train on Monday morning was passed by the passenger train which leaves Richmond at 6.40 a.m., and is due in Darlington at 7.24, at Catterick station—a station only about four miles from Richmond. Scorton station is the next, and Moulton the next—the distance between Catterick and Moulton being only a few miles. The passenger train stopped at both the stations, and was just on the point of leaving the latter when the cattle train rushed up. and committed great havoc with carriages and passengers. The passenger train comprised the engine and tender, a second-class carriage, a first class, and two third class, all of which contained passengers. Fortunately, however, at the rear of the passenger train were attached five empty carriages. These five carriages were smashed to atoms, the *debris* being scattered in all directions by the violence of the collision.

Accident on the Hammersmith and City Extension Railway.—On the night of the 6th ult., fourteen arches on the above line gave way in the Silchester Road, Bayswater, causing the death of six men. The Hammersmith and City Viaduct Railway, in connection with the Uunerground Railway, at Paddington, a distance of 2½ miles, was in course of construction, under Mr. Rummings, the contractor. A few days previous to the accident the woodwork of these arches was struck, and they were believed to be perfectly secure, but owing to the looseness of the soil for some time past many of the workmen had intimated their opinion that the foundations were insecure, and the recent storms and heavy falls of rain had evidently so sapped the foundations as to cause the greatest alarm. In the after part of the day it was observed by some of the workmen that a breach had taken place in one of the arches at the point of the road opposite to the Lancaster Hotel, and on that being reported to the contractor and his foremen, a number of workmen were employed to shore up the fractured arch. No sooner had they commenced the work of shoring than the arch gave way, carrying with it 13 others, making 14 in all, six of the men employed being buried in the mass of brickwork.

Boiler Accident at the Great Western Station at Paddington.—A fatal accident took place on the 8th ult. at the Great Western Railway Station, Paddington, by the bursting of a boiler. It appears that three men were pursuing their ordinary business in the engine-house at 5.40 that morning. From some cause which cannot be ascertained, the boiler of the engine named The Perseus suddenly burst and killed two men. The explosion was of so forcible a nature as to blow off a great part of the roof of the engine-house. The engine itself was soon discovered to be a complete wreck, and a piece of the boiler, weighing 15 cwt., was thrown to a distance of 150 yards from the scene of the accident. The cause of this accident is attributed to corrosion of the plates.

Accident on the Caledonian Railway.—An accident occurred on the morning of the 8th ult, shortly after ten o'clock, near the Gartcosh station of the Caledonian Railway. The ten a.m. train left Airdrie for Glasgow with a larger complement of passengers than usual, on their way to attend the Glasgow weekly market. The train progressed along the line in safety until within a short distance of the Gartcosh station, when the coupling between the engine and the first passenger gave way. As a matter of course, the engine, getting rid of the drag of the carriages, immediately started forward, and got some distance in advance of the train. Unfortunately the engineer, who appears to have lost presence of mind, shut off the steam and, applying the drag, brought the engine to a stand-still. The train of carriages, which at the moment of their disjunction from the engine were going along at a speed of 25 to 30 miles per hour, retained a great part of their momentum, and ran into the tender and engine almost immediately.

Singular Railway Accident.—The express and other trains going to Scotland on the North Eastern Railway were delayed some time on the afternoon of the 15th ult., by an accident which occurred at the Felling Station, the station next to Gateshead. The local train which left Newcastle for Shields and Sunderland at 3 o'clock in the afternoon was standing at the Felling Station about a quarter past 3 o'clock, taking in and discharging passengers; and while some of the passengers were alighting, a goods' "pick-up" train came from the south upon the opposite pair of rails on the down line at full speed, the local train standing on the up line. Just as the goods' train was flying past one of the tires of a truck in the centre of it broke, and in an instant several of the waggons were thrown off the line and driven in every direction. Large fragments from the broken waggons struck the carriages of the standing passenger train, and did extensive damage to them; but, singular to say, none of the passengers were seriously hurt, and but few of them slightly so. Of the goods' train one of the trucks was broken up into splinters and scattered over the platform of the station, and two or three others were nearly demolished.

ACCIDENTS TO MINES, MACHINERY, &c.

Collapse of a New Gasometer.—A singular accident has happened to a gasometer in Halifax. The gasometer, a new one, 100ft. in diameter, and weighing 70 tons, was being tried with air; and owing, it is supposed, to the imperfection of the metal tank, one side of the gasometer was caught, causing the immense body to break through the middle.

Colliery Explosion near Newcastle.—The colliery at which this accident, causing the loss of sixteen lives, occurred, is the property of Messrs. Lambert and Co., consisting of two pits—one, the Ann pit, situate in the village of Walker, and the other the Jane pit—the latter being about half a mile to the south of the former. The Ann pit is the down-cast, and the Jane the up-cast or furnace pit. About two o'clock on the morning of the 22nd ult. a party of about 24 men went down the Ann pit to work, some of whom had to attend to a "trouble" which had been come to in the workings. Between five and six o'clock, the man who was acting as banksman at the Ann pit was startled by a rush of air taking place up the shaft, accompanied by some straw and dirt. He at once gave the alarm. In a few minutes afterwards the resident viewer and the overman, together with a party of about twenty men, arrived at the colliery, and went down the pit, when they found that it had fired at the north part of the working. They likewise found that the stoppings, &c., connected with the ventilation of the pit had been carried away and destroyed by the force of the explosion, and also that there was considerable fire-damp in the workings. Happily, a number of men in the pit at the time of the accident were some distance from the scene of the explosion, and near to the shaft of the Jane pit. These accordingly came up at once.

BOILER EXPLOSIONS.

The Manchester Association for the Prevention of Steam Boiler Explosions.—At the ordinary monthly meeting of the Executive Committee of this Association on October 28th, 1862, the chief engineer presented his monthly report, of which the following is an abstract:—"During the past month there have been examined 353 engines and 539 boilers. Of the latter 8 have been examined specially, 9 internally, 48 thoroughly, and 463 externally, in which the following defects have been found:—Fracture, 7 (1 dangerous); corrosion, 30 (3 dangerous); safety-valves out of order, 15; water gauges ditto, 6; pressure gauges ditto, 20; feed apparatus ditto, 7; blow-off cocks ditto, 27; furnaces out of shape, 3; blistered plates, 5. Total, 121 (4 dangerous). Boilers without glass water gauges, 8; without pressure gauges, 7; without blow-off cocks, 18; without back pressure valves, 50. Three explosions have occurred during the past month to boilers not under the inspection of this Association, these boilers were in the iron districts, and of the externally-fired hay stack class; they were reported as having been of original defective construction, being insufficiently stayed. One of these explosions was attended with fatal consequences, the engineman being killed. The number of boilers under inspection which suffer from incrustation is very large; indeed, to escape this inconvenience is quite exceptional. It forms a considerable impediment to satisfactory inspection, since it renders it difficult to ascertain the actual condition of the plates; it sometimes gives a delusive appearance, and leads to undue suspicion of corrosion, but more frequently it conceals defects, since corrosion is often found to be going on under, and to be caused by, the deposit. In addition to the waste of fuel occasioned by incrustation, the wear and tear of boilers is considerably increased, apart from the effects of overheating. Thus internally double-flued boilers suffer from the the undue longitudinal expansion given to the furnace crowns, which increases the tendency to groove at the front end plate, an action always more or less developed in these boilers, while incrustation renders the use of tubular boilers altogether impracticable in localities not supplied with good water, and thus prevents the more general use of this economical class of boiler. Although the danger of allowing incrustation to form on plates exposed to the action of the fire is too fully appreciated to need remark, the fact is not so fully recognised that even where no actual cake of deposit is formed, overheating frequently occurs. It is thought that this may, in many cases, be due to the presence of thickening matter held in suspension in the water, and it would be interesting to ascertain by experiment whether the impediment thus presented to the free escape of the steam does not—where the circulation is imperfect, or no such agitation of the boiler takes place as in locomotives when running—lift the water off the plates, and thus cause overheating. Of the fact of overheating occurring where no incrustation is formed, and with an ample supply of water in the boiler at the time, there is no doubt, instances are constantly coming under notice, and it may be added that they are chiefly found to take place in boilers externally fired. Apart from the injury done to the boilers from incrustation, a considerable amount of earthy matter passes over with the steam into the engines, and thus renders necessary the use of an increased amount of tallow for the piston and slides. This, though too frequently lost sight of, is illustrated by the fact that where boilers are fed from brooks, subject, on heavy rains, to sudden torrents which stir up the mud, the engine attendants are in the habit, at such times, of taking the precaution of giving the engine cylinders an extra amount of lubrication, finding the pistons, &c., to clog when this is neglected. Under ordinary circumstances, the most practical plan for the prevention of incrustation is the adoption of an efficient mode of 'blowing-out,' and not the use of 'boiler-compositions.' To blow out, however, from one point only, at the bottom of the boiler, which is the general custom, has but a very limited and local effect. This is frequently remedied by the adoption of a perforated pipe, which is connected to the ordinary blow-out tap, and carried along the bottom of the boiler from one end to the other. These are technically termed 'Topham-pipes,' from the name of the patentee, and are generally spoken highly of by those of our members who have adopted them. They are, however, more successful where the sediment, being heavy and sludgy, falls to the bottom, rather than where it is of a lighter character, which frequently forms the hardest and most tenacious scale. From the rapid ebullition that takes place within boilers when under steam, it is found that a greater part, if not the whole, of the sediment set free by evaporation rises to the top of the water, forming a coat of scum, before finally depositing itself upon the furnace tubes or shell; and thus the readiest way of preventing incrustation is to blow out this layer of scum from the surface of the water by means of a scum pipe, before it has an opportunity of settling. There is nothing new or experimental in this, the system has been for years adopted with marine boilers, and there is no reason why its use should not become equally general with stationary ones. Many of our members have already tried it with considerable success, and find, on opening their boilers after a month or six weeks' work, that where they used formerly to be coated with a heavy muddy deposit they are now perfectly clean. The following is an explanation of the description of pipe adopted; It is about three or four inches in diameter, having a wing cast to it on each side, so as to form a trough throughout the entire length of the pipe. This pipe is carried within the boiler, from one end to the other, being made in any convenient lengths for introduction at the manhole; it is perforated with small holes on the top all the way along, the aggregate area of the whole number of these holes being equal to that of the pipe itself. The top of the trough is fixed a few inches below the level of the water, so that the scum on the surface may flow over it, when, being guarded from the disturbance of the ebullition, it deposits in the still water above the trough the sedimentary particles held by it in mechanical combination. A tap is fixed to the front end of the boiler, in communication with this pipe, by means of which it can be blown out as frequently as is desired, which should not be less than once every two hours, when ebullition is going on. This tap, which need not be more than two inches in diameter, should be entirely of brass, fitted with a gland, and have a neat waste pipe attached, which may be of wrought iron, while also the waste pipes from the glass water gauges may be connected to it, being led immediately under the dead plate, which arrangement is very compact and convenient. The best position for the scum pipe is at the side and not at the centre of the boiler, both on account of facility in fixing, and convenience in getting inside. A single pipe is sufficient. The above description is not by any means given as if that were the only form of scum pipe that could be advantageously applied. It was designed for the use of the members as being adapted to stationary boilers, simple in construction, affording a large collecting area, being free from any patent right. Upwards of a year's trial has proved it to be successful, and its more general adoption is consequently recommended. These pipes have already been made by the manufacturing engineers of Rochdale, Bolton, Bury, and other places, but are needed more generally, and a drawing at the office is open to inspection for the benefit of our members. There are other plans in operation which, however, are subject to patent right. One of these consists of a series of vertical pipes, fixed in the centre of the boiler, each pipe having a trumpet mouth, to which a vertical telescopic movement being effected by a copper ball float, so that the trumpet mouth rises and falls on the change of water level, like a buoy on the rise and fall of the tide; the object being to keep the mouth of the pipe immediately below the surface of the water, in close proximity to the scum. A second plan consists of a trumpet mouth laid horizontally. Both of these arrangements are reported to give satisfaction, and, whenever opportunity offers, the results of their working will be noted, and particulars of the plan found to be most successful communicated to the members. Some descriptions of incrustation, however, cannot be entirely removed by any blowing-out apparatus alone, however perfect; in such cases, a little carbonate of soda may be added, which many of our members have applied with considerable success. Of the use of this their experience is decidely in favour, while the testimony with regard to complicated "boiler compositions" generally is that they found them expensive, in many cases useless, in others injurious, and have in the majority of instances, discontinued them altogether. For fuller chemical particulars refer to Dr. Angus Smith's report to the Executive Committee upon the Incrustation in Boilers. The use of soda, without a scum pipe, is found in some cases to induce priming; the soda combining with the grease within the boiler, and producing foaming of the water. The most radical cure for the prevention of incrustation, though one involving considerably more outlay, at the first, than the above, will be found in the adoption of dry or "surface condensation," by means of which the boiler is fed with distilled water, the same being used again and again, with the exception of the slight amount lost through leakage. To those who are paying large amounts annually for a supply of town's water, and where the steam is consumed for engine purposes, the adoption of surface condensers is well worthy of serious consideration not only on account of the saving in the water rates, but also in that of fuel, since non-condensing engines may, by this means, be converted into condensing, which is not at present generally the case where town's water is used.

BRIDGES.

Railway Bridges over the Thames.—The Thames will shortly be crossed by no less than five bridges for railways. The Charing Cross Railway will have two of these bridges, one at Hungerford, and a second at Cannon-street, for the city extension. The London, Chatham, and Dover, will have one near Blackfriars, to bring that line into Farringdon-street. There is a bridge nearly completed higher up the river for the North and South London junction, which will admit of the trains of the London and North Western and the Great Western Railways, passing to the Surrey side, and these can recross the river by the railway bridge at Battersea, and avail themselves of the west-end station at Pimlico.

DOCKS, HARBOURS, &c.

Hydraulic Power at the Liverpool Docks.—The Mersey Docks and Harbour Board have agreed to apply hydraulic power to the gates at the Wellington half-tide dock, the Huskisson locks, the Sandon dock entrance, and the outer storm gates at the two last-named docks, and also to provide two hydraulic capstans on the pierheads of Sandon basin, at an estimated cost of £9205. Great advantages will result to the working of the trade of these docks by the application of hydraulic power; the gates, by these means, will be opened or closed in three minutes, whereas, by the old system, half an hour was occupied in the performance of this operation; so that, after hydraulic power has been applied to these gates, they will be kept open for the admission of ships 20 minutes longer than at present.

The Dockyards.—A parliamentary return, pursuant to orders of the House of Commons, of June 30 and July 15 last, has just been issued, showing the number and area of the dockyard basins, the depth of water, the width of lock or entrance gates, &c.; and also the number of docks (including those in course of being constructed or enlarged) capable of admitting at spring tides and neap tides respectively, and at certain specified draughts, the several classes of iron-cased ships, built or building, exclusive of the floating batteries built for the Russian war. In all there are eight dockyards—Deptford, Woolwich, Chatham, Sheerness, Portsmouth, Devonport, Keyham, and Pembroke, of which Chatham and Pembroke have no basins, but the remainder have 11 basins in all, with a total water area of 36 acres 1 rood 10 perches, and 13,511 lineal feet of quay space. The basin with the widest entrance is the boat basin, at Sheerness, which is 100 ft. wide, but the depth of water in it is inconsiderable, 26 ft. at high water spring tides, and 21 ft. 6 in. at ordinary high water neap tides, and the water area is little more than one acre. The deepest and largest basins are the Keyham south basin, with an entrance lock of 252 ft. 8 in. between caissons, a water area of 7 acres 32 poles, 2150 ft. of quay space, an entrance 80 ft. wide, and a depth of water at the outer entrance, at the high water spring tides, of 36 ft., at the inner entrance of 34 ft., and at the ordinary high water neap tides—outer entrance, 31 ft. 6 in.; inner entrance, 39 ft. 6 in. The Keyham north basin—water area, 5 acres; 1,350 ft. of quay space; width of entrance, 80 ft.; depth at high water spring tides, 27 ft.; at neap tides, 22 ft. 6 in. The Portsmouth steam basin—water area, 7 acres; 2,190 ft. of quay space; two docks capable when unoccupied of being used as a lock, 644 ft. long, with 27 ft. at high water spring tides, an entrance 80 ft. wide; depth of water at high water spring tides, 25 ft., at neap tides, 21 ft. Portsmouth south basin—water area, 2 acres 1 rood 30 poles; quay space 950 ft.; width of entrance, 67 ft.; depth of water, at high water spring tides, 24 ft. 6 in.; at neap tides, 20 ft. 6 in.; and Devonport basin, with a water area of 1½ acres, a quay space of 800 ft., an entrance 74 ft. wide, and a depth of 30 ft. 6 in. at high water spring tides, and 26 ft. at the ordinary neap tides. There are in all three docks capable of admitting ships of the *Northumberland* and *Warrior* class at load draught, at high water spring tides—one at Portsmouth, one at Devonport, and one at Keyham; and a fourth dock at Portsmouth capable of admitting such ships when lightened one foot. At Devonport and Keyham these docks will also admit the vessels at ordinary high-water neap tides, this being accomplished at Keyham by the water being raised in the basin by pumping; and one of the docks at Portsmouth will admit the vessels when lightened three feet. The *Resistance* class of vessels are admitted into 11 docks in all—viz., at high-water spring tides, and at load draught, into six docks—four at Portsmouth, one at Devonport, and one at Keyham; and into the remaining five docks as follows—viz., when lightened 1 ft. into one dock at Pembroke, when lightened 2 ft. into one dock at Chatham, and when lengthened 3 ft. into one dock at Portsmouth and two at Keyham. The docks available at ordinary high-water neap tides are, at load draught, one at Devonport and one at Keyham, and when the vessels are lightened 3 ft. one at Portsmouth and two at Keyham. The *Valiant* class are also admitted into the same number of docks as the *Resistance* class, with the addition that there is another dock at Portsmouth available at high-water neap tides. The *Prince Albert* class are admitted into 22 docks in all—viz., at high-water tides and at load draught into 20 docks—three at Woolwich, two at Chatham, three at Sheerness, six at Portsmouth, two at Devonport, three at Keyham, and one at Pembroke, and into the remaining two, when lightened 2 ft., one of these being at Chatham and the other at Devonport. At ordinary high-water neap tides, 18 of these are available as follows, viz., 10 at load draught, of which there are one at Chatham, four at Portsmouth, two at Devonport, and three at Keyham; seven when lightened 2 ft., of which there are one at Woolwich, one at Chatham, three at Sheerness, one at Portsmouth, and one at Pembroke; and one, when lightened 3 ft., at Portsmouth. The *Caledonia* class are admitted into nine docks at high-water spring tides—viz., four at load draught, of which there are one at Portsmouth, two at Devonport, and one at Keyham; three when lightened 1 ft., at Portsmouth, and two when lightened 3 ft., of which there is one at Chatham and one at Pembroke. At ordinary high-water neap tides two of these are available, one at Devonport and one at Keyham, both at load draught. The *Zealous* class are admitted into 12 docks at high-water spring tides—viz., six at load draught, of which three are at Portsmouth, two at Devonport, and one at Keyham; one when lightened 1 ft. at Portsmouth, one when lightened 2 ft. at Pembroke, and four when lightened 3 ft., of which one is at Chatham, one at Portsmouth, and two at Keyham. Of these, six are available at high-water neap tides—viz., two at load draught, of which one is at Devonport and one at Keyham; and four when lightened 3 ft.—one at Portsmouth, one at Devonport, and two at Keyham. The *Royal Sovereign* class are admitted into 15 docks at high-water spring tides—viz., eight at load draught, of which there are four at Chatham, two at Devonport, one at Keyham, and one at Pembroke; three when lightened 1 ft., of which there are one at Portsmouth and two at Keyham; one when lightened 2 ft. at Portsmouth, and three when lightened 3 ft., of which two are at Woolwich and one at Devonport. At high-water neap tides eight of these docks are available—viz., two at load draught, of which one is at Devonport and one at Keyham; four when lightened 1 ft., of which one is at Portsmouth, one at Devonport, and two at Keyham; and two when lightened 2 ft., at Portsmouth. The *Favourite* class have 24 docks available at high-water spring tides—viz., 17 at load draught, two when lightened 1 ft., three when lightened 2 ft., and two when lightened 3 ft. Of these, 12 are available at high-water neap tides—viz., eight at load draught, three when lightened 2 ft., and one when lightened 3 ft.

CANALS.

The Madras Irrigation and Canal Company.—In the report of the directors to the seventh ordinary general meeting of the company, held on the 27th ult., attention is called to the fact, that the portion of the year corresponding with that which has passed since their last report, must always be, from natural causes, the most unfavourable for executive operations. The south-west monsoon commences in May, producing disease and consequent desertion of labourers, and this is followed by the rains in June, which usually continue until October, rendering a partial suspension of out-door labour during that time absolutely necessary; nevertheless, although the floods of the current year, in the locality of Kurnool and the adjacent districts have been very unusually heavy, nothwithstanding these obstacles, the construction of the Anicut across the Toombuddra at Soonkasala, and of the aqueduct over the river Hindry at Kurnool from (both considerable undertakings) has been carried on with commendable expedition, and great zeal and energy have been displayed by the chief engineer and his executive staff in prosecuting, as rapidly as the transfer of land to the company would allow, the excavation of the first and second divisions of the main canal, and the subsidiary works of distribution; and the chief engineer remains firm in his previously expressed conviction, that his original estimate for the whole line of works from Soonkasala to the coast will not be exceeded, if his plans are carried out without further obstruction or delay. It appears that the construction of the Anicut at Soonkasala proceeded rapidly until June last, when the floods commenced and prevented further progress. At that time the inequalities in the bed of the river had been filled in, and the superstructure had, according to the expectation formerly expressed, attained a height sufficient to maintain a supply of water to the main canal of the depth of three feet. The preparation of cut stone for the under sluices was also, during the suspension of operations on the mainwork proceeded with, and on the 1st of October, the river had so far subsided as to permit a resumption of labour on the Anicut itself, and then it was found that the work previously executed had withstood the floods most satisfactorily. The heavy masonry work of the head sluices of the main channel had also up to the last-mentioned date progressed steadily, though not so rapidly as might have been the case, if a larger number of stone cutters could have been procured. The main canal from the Anicut to the Hindry Aqueduct, a distance of 17½ miles, has been nearly completed, including the distributing sluices, the culverts for drainage, and the calingulahs or escapes, although the greater portion has been cut through compact rock; indeed, for some time past, this length of channel has been ready to receive at least three feet depth of water. The Hindry Aqueduct, a work of great extent and importance, was by much exertion completed to above the height of the floods before the early freshes of the river came down at the end of April last. The completion of this great work, according to the statement of the chief engineer, will probably be achieved in July next; and, if so, its erection will have occupied an exceedingly short period, and will be highly creditable to its constructors. The section of the main canal from the Hindry aqueduct to Nagatoor, a length of 26 miles, terminating at the 43rd mile from Soonkasala, has been partially excavated, and the chief engineer has expressed a hope that he will be able to have the whole of this section ready to receive water in July next. From the 43rd to the 72nd mile, the excavation of the chief canal has also been commenced, and the strength of the working parties by the latest accounts was being expeditiously augmented. Plans and estimates of the channels for irrigating the whole of the land commanded by the main canal thus far have been approved, and preparations made for rapid construction. The hospital at Kurnool has been completed, and various other buildings, workshops, &c., in the foregoing portion of the undertaking, have been finished, or are in satisfactory progress. The transfer of the necessary land for the next portion of the Main Channel, *i.e.*, from the 72nd to the 91st mile, was at the end of September last being promptly made, and partial excavation had then commenced, the plans and estimates of the whole having been sanctioned. In this section a fall of 200 feet has been provided for by locks, the chambers whereof will be 120 feet in length and 20 feet in breadth, and will be capable of being filled very quickly; at the same time, their cost will be within the Chief Engineer's original estimate of £100 per foot of lift. The supply of labour in the several sections just described has been fluctuating; for instance, there were at one time engaged upon the first section only, over 20,000 labourers; subsequently, little more than 9,000 were at work upon a more extended area; but, on the 1st of October, the number had increased to 14,000, and others were rapidly joining. The plans and estimates of the 12 miles of canal following those last referred to, and which embrace an Anicut across the River Caulee, in the Koondair Valley, with head sluices and locks for the continuation of the main channel, were placed before the Government, in September last, for approval, and preparations had then been made to commence construction without delay. In the succeeding section, *i.e.*, from the 103rd to the 133rd mile, detailed plans and estimates were, when the Chief Engineer last reported, very near to completion. Working plans and estimates of the further portion of the main line, extending from the last-mentioned section to Cuddapah, were finished, and under examination by the Chief Engineer on the 1st of October last. These plans, however, include an Anicut across the Pennair River, to which objections appear to have been entertained by the Government, who had suggested an aqueduct in its stead. From Cuddapah to Somaishwarum, the line of main canal had been laid out, and plans and estimates thereof prepared at the date of the last advices from India, but the Chief Engineer was about to make a close personal investigation of the locality, prior to determining the final arrangement. With regard to the terminal or Coast Section of the works from Soonkasala, viz.: that which will commence with an Anicut on the Pennair at Somaishwarum, and proceed through Nellore to Kistnapatam, on the Coromandel coast, a length of seventy miles, the Directors are now able to report that Sir Charles Wood has lately issued to the Madras Government direct instructions to sanction constructive operations; and, as the plans and estimates were prepared nearly two years since, and were placed before the Government for approval in March last, they have little doubt that active construction has ere now been entered upon; at the same time, it is gratifying to record the fact that the claim of the Company to this essential outlet for the upper portion of their scheme is no longer questioned by the Secretary of State.

Ship Canal across the Isthmus of Corinth.—A company has been formed in Greece for cutting through the Isthmus of Corinth, and thus avoiding the long and dangerous coasting of the shores of the Peloponnesus. The width of the canal would be 112ft., and its depth about 20ft. Its length would not exceed three miles and three-quarters. The advantages to navigation to be derived from the cutting of the isthmus are easily perceived. For vessels on their way from Marseilles and the Mediterranean to the Piræus, the distance would be shortened by 90 miles. The saving of time to vessels coming from the Adriatic would be still more considerable.

GAS SUPPLY.

GAS IN NEW ZEALAND.—A gas-light company has been formed for the purpose of lighting Auckland, the seat of Government of New Zealand. The contract for the erection of the works has been awarded to Mr. A. K. Smith, of Melbourne, who will build them at a cost of £16,000.

APPLICATION OF PETROLEUM GAS TO STEAM-SHIPS.—The *Resistance*, iron ram, steamed out of Portsmouth Harbour on the 19th ult., and, taking in shell at Spithead, sailed for Lisbon. During the stay of the *Resistance* at Portsmouth she has been re-fitted in a very complete manner with Mr. Gurney's oil-gas apparatus, for lighting up the engine-room, stoke-holes, &c. The system has been tested on board the ship during the time she has already been in commission, and has been attended with such satisfactory results that she has now been supplied with new retorts and gasometer, and fitted in a more complete and perfect manner than previously. The manufacture of the gas on board, so far, has been effected at a less cost than attended the use of the old oil lamp, while at the same time there is no possible comparison to be drawn between the brilliancy of the one light and the murky dimness of the other. Gallipoli oil is used to produce the gas, but it is calculated that petroleum could be advantageously substituted, the cost being much less, and the petroleum giving 40 per cent. more gas from a corresponding quantity of liquid. As the apparatus is fitted on board the *Resistance*, it is estimated that an apparatus capable of supplying 24 jets could be put up for about £28.

MINES, METALLURGY, &c.

MODE OF APPLYING THE ELECTRIC LIGHT FOR MINING PURPOSES.—MM. Dumas and Benoit have prepared an apparatus, which consists essentially of three parts—a battery, a Ruhmkorff's coil, and a Geissler's tube—the whole arranged so as to produce a sufficient light to illuminate the miner, and allow him to work in atmospheres where other lights fail. The light produced is cold, or rather does not heat the tube in which it is produced; and gas has no access to it; it is quite isolated. The apparatus is as complete as ordinary lamps, and there is no injurious emanation. It can be lighted or extinguished at will. It can work for twelve consecutive hours without diminution, and without requiring any change. The workman has only occasionally to agitate the carbon by means of a rod. The greatest difficulty consisted in being able to associate a battery of such intensity that the weight of the apparatus was as small as possible, the light produced of the greatest regularity, and its duration at least twelve hours. The present form of the apparatus, which may be still further diminished, is already so small that the miner can carry it without inconvenience, like a small carpet bag. The authors point out the advantages of such a mode of illumination, and state that the results obtained in using Becquerel's fluorescence-tubes have led to the expectation that the luminous effects may be greatly improved both as to duration and intensity.

PROPERTIES OF ALLOYS OF LEAD AND ZINC.—Messrs. A. Matthiessen and Von Bose have long been engaged in making a series of experiments on the properties of alloys; many of these have a very important practical bearing. Thus the possibility of making a practically useful compound by fusing lead and zinc together has often been tried without success. The cause of the failure has now been very clearly demonstrated by them. When lead and zinc are melted together, and allowed to cool slowly, the two metals separate, the lead sinking to the bottom, and the zinc rising to the top of the mass. The lead, however, is not absolutely pure, but contains about 1½ per cent. of zinc, and in the same manner the zinc contains rather more than 1 per cent. of lead. These experiments prove, that if we take lead and zinc in tolerably equal proportions, melt them together, and cool at the ordinary rate, the resulting mass will not be a useful uniform compound, but a mere mechanical mixture of nearly pure lead with zinc, also tolerably pure: such a mixture will necessarily be destitute of those properties which render good alloys useful in practical metal working. The same remarks also apply with equal force to a mixture of zinc and bismuth.

PEAT IRON.—At the meeting of the Royal Dublin Society on the 17th ult., R.H. Scott exhibited samples of iron reduced by patent peat fuel, at the Creevalea Iron Works, County Leitrim, under the management of Mr. G. Murrall. The fuel used in its manufacture was turf prepared according to Mr. Buckland's patent, but the process was as yet only an experiment; yet it was most promising. Mr. Scott read a paper containing a description of the county from which the iron was obtained, and also of the process by which the peat was converted into charcoal fit for the purpose for which it was intended. The sample of iron exhibited was the first of the kind produced in Ireland, and to Mr. Murrall was due the credit of its production. A letter was read from that gentleman giving some information as to the production of the iron by the process referred to, and testifying to its success—that the iron produced in that way was equal to any Russian or Swedish iron, and he anticipated that much benefit would result from the following out of the enterprise in Ireland.

ALUMINIUM is now being manufactured on a large scale by Messrs. Bell Brothers (the only licensees in England for Deville,s patent). This metal was first discovered by Sir H. Davy, Wöhler obtained it in June, 1827, and of a specific gravity of 2·5 (the same as glass). In 1854, Deville published the properties of aluminium. His process for manufacturing it, which is the same method as Messrs. Bell use, is as follows. Having obtained the chloride, Deville introduces into a wide glass or porcelain tube, 200 or 300 grammes of of this salt, between two plugs of asbestos, and allows a current of hydrogen to pass from the generator through a dessicating bottle containg sulphuric acid and tubes containing chloride of calcium, and finally through the tube containing the chloride, at the same time applying a gentle heat to the chloride, to drive off any free hydro-chloride acid which might be formed by the action of the air on it. He now introduces at the other extremity of the tube a porcelain boat, containing lodium, and when the lodium is fused the chloride of aluminium is heated, until its vapour comes in contact with the fused lodium. A powerful reaction ensues, considerble heat is evolved, and by continuing to pass the vapour of the chloride over the lodium, until the latter is all consumed, a mass is obtained in the boat of the double chloride of aluminiun and lodium, in which globules of the newly reduced metal are suspended. It is allowed to cool in the hydrogen, and then the mass is treated with water, in which the double chloride is soluble, the aluminium being unacted on. Bell Brothers exhibit this metal in the exhibition, and which shows the value of it for ornamental purposes, by the difficult castings exhibited, which run in one piece. Among the different things shown, is a balance, sextant, and other philosophical instruments. Aluminium forms, with copper, a very beautiful alloy named aluminium bronze. In colour and polish this substance resembles the finest gold, and at the same time is not only capable of being cast in moulds but also forged under the hammer like the softest iron, which metal in strength it far surpasses. Reid and Sons, gold and silversmiths, in Newcastle, also manufacture articles of this metal. Availing themselves of the brightness and cheapness, Reid and Sons have taken out a patent for manufacturing watch cases of this metal. These cases can not be distinguished from gold, and are as cheap as silver. From the above, when it is remembered that aluminium is incorrodible, and never blackens even in the most impure atmospheres, there appears every reason to hope that before long it will find extensive employment in the manufacture of our country.

REMARKABLE DISCOVERY OF METAL.—Professor Ansted, the eminent mineralogist, reports the discovery at St. Cuthbert's, in the Mendip Hills, about three miles from Wells, in Somersetshire, of a deposit of lead-producing *débris* of old mines and lead-washings of ancient miners, filling up the bed of a stream that flowed in former ages. The metallic slime of exceeding richness. amounts, he says, to 600,000 tons, extends over twenty-five acres to the depth of 30ft., and is computed to be worth half a million of money for the clad it contains.

LEAD ORE AT HARWOOD, DURHAM.—The discovery is announced of a rich vein of lead ore, in a very extensive mineral grant, situate on the eastern flank of the Valley of Harwood, county of Durham, about 11 miles from Alston. The sedimentary series, of which this formation is composed, has several productive beds, which crop out along the slope of the hill from the coal-sills above to the scar limestone below. It is in the latter rock that the discovery has been made; and it is a singular fact that former miners have been working in a vein parallel to the one just found at a distance of only three fathoms. Very little work has yet been done, but from the ground already opened, about 20 tons of lead ore has been extracted, and the vein seems to improve in strength and quality with every fathom opened. The end of the drift, 4ft. wide, is yielding 4 tons of ore per fm. and is set to four men to drive, at £3 3s. per fm.

REFINING IRON.—It has been proposed to substitute coal for the charcoal usually employed in the cementing troughs or cases in the manufacture of steel. The experiments of Macintosh prove that the cementation may be effected under the influence of a current of carburetted hydrogen, while coal on being calcined disengages large quantities of hydro-carburets. It has, however, been found necessary to abandon both the process of Macintosh and the use of coal, on account of the steel produced being of bad quality. Having ascertained the causes which render these processes defective, Messrs. Margueritte and De Sourdeval propose the adoption of a new process by which they hope to find a remedy. Both coal gas and coal in the purest state possess sulphuretted products, which would combine with the iron, and as infinitessimal quantities of sulphur are sufficient entirely to change the quality of the iron or steel, it will be apparent that it is highly necessary to remove it. This may be effected in the most simple and economical manner by adding to the coal a certain quantity of lime or carbonate of lime, which at the high temperature to which the mixture is raised becomes transformed into quicklime, and retains in this state of sulphuret of calcium not only the sulphur resulting from the distillation of the coal, but also that evolved in the furnace, which always filters into the cementing cases. The presence of the lime prevents an excess of sulphur being taken up by the iron, and also possesses the further advantage of removing the greater part of that which it previously contained; it thus purifies and refines the iron, and renders it more suitable for subsequent cementation, and, in fact, enables good steel to be obtained from iron of inferior quality. They effect this purification and desulphuration of the iron by means of hydrogen, which possesses (as is well known) the property, when passed over impure iron, of producing sulphuretted hydrogen readily decomposable in lime. Carbonates of baryta, strontium, soda, or potash may be employed for producing the same result; but as these are either fusible or volatile, and also much higher in price than lime, they prefer the latter alkali as being completely infusible, and of a fixed nature, besides being the cheapest of all the matters suitable for employment. The coal and quicklime, or the carbonate, are pulverised and mixed together in the proportions of from 15 to 20 or 25 per cent. of the quantity of coal employed. The coke residue of the cementing process is employed for heating purposes in the next operation. The apparatus they prefer to use are small retorts and furnaces, similar to those used by the Vielle Montagne Company for the manufacture of zinc. These retorts, by reason of their small dimensions, may be readily brought to a red heat, which is the most favourable for the cementation, while it is very difficult for the heat to penetrate to the centre of the ordinary cementing cases. It will be easily understood that such a furnace, containing from 40 to 50 retorts, would produce, after a few hours' continuous action, a considerable quantity of steel. The results obtained by calcining bars and plates of bad quality in a mixture of coal and quicklime, or carbonate of lime, surpass all expectation, steel of very good quality being produced from iron which previously was unsuitable both for forging and bending. These improved processes may also be applied for the improvement of cast and malleable cast iron. This invention, therefore, consists, first, in the simultaneous purification, refinement, and cementation of iron by calcining it in a mixture of coal and alkaline carbonate or earthy alkali, preference in all cases being given to lime or its carbonate; second, in the use of furnaces or retorts similar to those used in the manufacture of zinc, enabling the iron to be raised to the most favourable temperature for cementation, also rendering the operation continuous and economical by successive supplies of material; third, in the employment of any other combustible material as a substitute for the coal capable of furnishing hydrogen by distillation, such as lignites, anthracite, peat, wood, and other matters mixed with lime for the simultaneous purification and cementation of iron; fourth, the simultaneous contact of non-carbonated hydrogen and lime, with iron divided into thin sheets, for the purpose of purifying it only without cementing it. In this case the hydrogen may be produced by passing steam over charcoal, or by the action of sulphuric or hydrochloric acid on zinc or iron. The hydrogen acting at a high temperature on the iron in contact with lime has the effect of purifying it, so as to change inferior iron into iron of very good quality.

APPLIED CHEMISTRY.

PRESERVATIVE ACTION OF SULPHATE OF COPPER ON WOOD.—The experiments of Mr. Kœnig are stated to have demonstrated that sulphate of copper deprives wood of the nitrogenous matter which acts as a ferment, this matter being found in the solution of copper. At the same time a combination of resin and copper is formed, which closes up the pores of the wood and preserves it from the action of the air. The wood, however, is still susceptible of decomposition, in consequence of the variations of temperature and humidity. Mr. Welt, while occupied with the solution of the last questions, has arrived at the following conclusions. He has remarked that the wood gradually blackens as the layers of metallic copper are produced on it. The sulphate of copper is fixed on the wood; this salt decomposes itself into metallic copper and sulphuric acid. The latter chars the wood; and it is through this layer of charcoal, that the wood is enabled to resist the action of humidity.

THE ANALYSIS OF THE IODINE OF COMMERCE is now made by means of a solution of nitrate of silver, sulphurous acid being employed as a solvent; but, on account of the weak concentration of the latter, the iodine dissolves very slowly. M. Hesse states that the process may be greatly expedited by substituting an alkaline sulphite for the sulphurous acid. He employs a solution of ammonia, saturated with sulphurous acid, the precipitation of the iodine being made in the ordinary manner. Often the iodate of silver precipitated contains a small quantity of sulphate of silver, which may be removed by boiling in water acidulated with nitric acid.

ON THE MEDICO-LEGAL DETECTION OF SILVER.—M. Nicklès having to determine the nature of some suspected spots on body linen, and having detected the presence of silver, devised the following process, borrowed from the electrotype method, to withdraw the silver, and, in spite of the small quantity operated upon, presented it in a state easy to be recognised. This process leaves nothing to be desired, either in promptness, simplicity, and still less in precision. To the matters in which the silver is supposed to exist (being, of course, previously assured of the absence of other metals, as lead, mercury, &c.) add some cyanide of potassium, and plunge into one side of the liquid a well-scoured copper wire attached to the negative pole, and to the other a graphite crayon, closing the extremity of the positive pole of a galvanic pile. It is essential that a galvanic current should be employed, sufficiently feeble to prevent the disengagement of hydrogen round the copper wire attached to the negative pole; otherwise, the silver deposit does not adhere, and becomes more or less pulverulent. When the quantity of silver to be discovered is excessively small, the extent of the deposit should be very limited, in order to make it as distinct as possible; in fact, only the end of the copper wire should be immersed. In operating under favourable circumstances, the salt silvers with the greatest facility. The above process is perfectly well adapted for the extraction of silver from the residuums of this metal. The silver is reduced to the state of chloride, well washed, and dissolved in cyanide of potassium, before exposure to the action of the pile.

LIST OF APPLICATIONS FOR LETTERS PATENT.

WE HAVE ADOPTED A NEW ARRANGEMENT OF THE PROVISIONAL PROTECTIONS APPLIED FOR BY INVENTORS AT THE GREAT SEAL PATENT OFFICE. IF ANY DIFFICULTY SHOULD ARISE WITH REFERENCE TO THE NAMES, ADDRESSES, OR TITLES GIVEN IN THE LIST, THE REQUISITE INFORMATION WILL BE FURNISHED, FREE OF EXPENSE, FROM THE OFFICE, BY ADDRESSING A LETTER, PREPAID, TO THE EDITOR OF "THE ARTIZAN."

DATED OCTOBER 28th, 1862.

2897 J. Chalmers—Armour plating ships of war and fortifications.
2898 E. Hooper—Roofing tiles.
2899 J. & J. Fletcher—Shaping iron and other metals.
2900 E. & A. Tatham—Warp machines for the manufacture of looped fabrics.
2901 H. Allen—Preparing leaves and stalks of plants for being cleaned or dressed for the purpose of obtaining the useful fibres they contain.
2902 G. H. Smith—Crinoline or elastic hoops for dresses.
2903 E. S. Tudor—Purification of lead.
2904 C. S. Duncan—Compound or material for coating or covering metallic and vegetable substances to preserve them from corrosion or decay.
2905 J. Jeffreys—Surface condensers and apparatus for heating and cooling fluids.
2906 T. Sutton—Preparing albumenized paper for photographic purposes.

DATED OCTOBER 29th, 1862.

2907 A. Ripley—Pistons for steam engines and air and liquid pumps.
2908 A. Shanks & F. Kohn—Hydrostatic presses.
2909 G. Darlington—Zinc oxide.
2910 A. Krupp—Breech-loading ordnance and fire arms.
2911 A. Hogg—Smoothing irons.
2912 W. Clark—Apparatus for ascertaining and recording the speed and distance travelled by vehicles, the flow and quantity of water, and other analogous purposes.
2913 W. Clark—Treatment of copper ores.
2914 I. W. Lister & J. & W. Bottomley—Looms for weaving.
2915 W. Cooke—Apparatus for ventilating.
2916 W. E. Evans—Apparatus for playing organs, harmoniums, pianos, and other similar keyed instruments, and also improvements in reed musical instruments.
2917 W. E. Gedge—Apparatus in connection with the pans of water closets.
2918 W. E. Gedge—Looms for weaving.
2919 D. Fryer & J. W. Mears—Casks, tanks, or other receptacles for containing petroleum and other oils or spirits.
2920 J. Head—Machinery employed when cultivating land by steam power.
2921 J. Unsworth—Steam engines.
2922 F. L. Stott—Apparatus for warping yarns or threads.
2923 H. P. F. Newham—Reversible shawls.
2924 J. & J. Fletcher—Wrought iron wheels.

DATED OCTOBER 30th, 1862.

2925 J. Lockwood—Boilers.
2926 H. Eastwood—Boilers and furnaces.
2927 F. Gregory—Pressing seeds, fruits, hops, and other substances.
2928 G. Mayall & J. Hollingworth—Preparing cotton and other fibrous materials for spinning.
2929 J. Eaton—Gas burners for illuminating purposes.
2930 G. Piggott—Punching, shearing, and rivetting sheets or plates of iron and other metals and alloys.
2931 P. Giffard—Air guns and other air arms.
2932 J. Horton—Armour plated ships and fortifications.
2933 J. Birch—Clearing from obstructions drains, water-closets, stach water and other pipes.
2934 A. Guild—Preparing and treating the leaves and stalks of fibre-yielding plants and for cleaning and dressing the same.
2935 G. Haseltine—Horse shoe machines.

DATED OCTOBER 31st, 1862.

2936 W. Astrop—Manufacture of paper.
2937 W. R. Bowditch—Carburetting or napthalizing gas.
2938 H. L. Corlett—Construction of tuyeres.
2939 G. Dickinson & E. Cooke—Construction and ornamentation of metallic bedsteads, couches, and children's cots.
2940 D. Spink—Propelling ships and other vessels.
2941 A. Andrews—Cutting and rasping pegs in boots and shoes.
2942 C. Gubbins—Irons for ironing.
2943 G. H. Morgan—Raising and lowering bodies.
2944 H. Thomson—Railway signals.
2945 M. C. de Casteras Sinibaldi—Armour plates for ships, fortifications, and forts.
2946 G. Speight—Collars for men's wear.
2947 H. Williams & J. Maxton—Lace or trimmings made on bobbin net or twist lace machines.
2948 T. Gibson, T. Hall, & T. Davison—Railway breaks.
2949 W. E. Newton—Carriages and beds of guns, mortars, and other ordnance.
2950 F. E. Sickels—Steering or manœuvring ships or boats.
2951 J. G. Marshall—Treatment of the straw of flax, hemp, and other vegetable substances preparatory to spinning the fibre thereof.
2952 W. Jenkins—Cutting coal.
2953 J. J. Anderson—Production of leather from waste leather scraps.

DATED NOVEMBER 1st, 1862.

2954 W. Tarr & E. Farr—Pianofortes.
2955 J. W. Taylor—Cleansing woollen, worsted, and cotton fabrics, and other fibrous materials.
2956 E. Field & M. & R. M. Merryweather—Steam fire engines.
2957 G. Haseltine—Burial cases.
2958 E. Stevens—Iron shelves, stands, and racks.
2959 W. E. Newton—Drying grain and other substances.
2960 E. Hopkins—Treating ores for the extraction of metals therefrom.
2961 J. Winter—Safety tap or cock.

DATED NOVEMBER 3rd, 1862.

2962 F. Tussaud—Cutting metals.
2963 J. Musgrave—Valves of steam hammers and steam hydraulic and gas engines.
2964 C. Shield—Malleable cast iron.
2965 L. Gones—Seat or chair forming also a travelling bag.
2966 F. Trachsel & T. Clayton—Obtaining light, heat, and ventilation.
2967 G. Hollins—Straps or belts for machinery.
2968 E. Humphrys—Centrifugal pumps.
2969 W. Clark—Castors.
2970 T. O. Clark—Portable spring bottom bedstead.
2971 D. Scattergood—Circular frames for the manufacture of looped fabrics.
2972 P. F. C. Cheveron & E. C. Eichenberg—Shawls and other figured tissues.
2973 R. A. Brooman—Moulding and compressing artificial fuel, peat, bricks, and tiles.
2974 W. H. Stallard—Umbrellas and parasols.

DATED NOVEMBER 4th, 1862.

2975 J. B. Francis—Raising and lowering window blinds, maps, and other articles for retaining them in position.
2976 J. Lefebvre—Instruments for indicating angles or variations of level and for measuring horizontal and vertical distances.
2977 F. Duraud—Cotton gin.
2978 J. McKean & T. Greenhall—Dressing yarns or textile materials.
2979 J. H. Johnson—Hanging, arranging, and operating ordnance.
2980 T. Logan—Kaleidoscope.
2981 J. Place—Looms for weaving.
2982 P. W. Renter—Dyeing.
2983 T. Huntley—Kitcheners and kitchen ranges, and cooking and bath heating apparatuses.
2984 R. A. Brooman—Fringes.
2985 J. Shirt—Condensing the steam of high pressure steam engines.
2986 J. E. F. Ludeke—Magneto electric apparatus for obtaining and applying motive power.
2987 A. C. Davies—Lubricator.
2988 A. Wall—Purifying lead, and extracting and separating silver therefrom.

DATED NOVEMBER 5th, 1862.

2989 J. B. Thomas—Railway signal discs.
2990 S. Robotham—Carriage bodies.
2991 J. Banwell—Punching by means of hydraulic pressure.
2992 W. Johnson—Standards for supporting telegraph wires.
2993 R. A. Brooman—Commodes or water closets.
2994 R. A. Brooman—Taps or cocks.
2995 R. A. Brooman—Spinning frames.
2996 C. Shield—Malleable cast iron.
2997 A. V. Newton—Printing surfaces, dies, and substitutes for photographic negatives.
2998 J. Petrie & J. Teal—Washing wool and other fibrous materials.
2999 S. Tragheim—Treating hemp preparatory to its being spun.
3000 D. Hill—Marking and counting bank notes and other documents.
3001 J. J. Laveissiere—Tubes of copper or other metals or alloys.
3002 T. Brown—Surfacing fibrous materials.

DATED NOVEMBER 6th, 1862.

3003 F. Goodyear—Plaiting straw.
3004 W. E. Gedge—Lift and force pump.
3005 B. T. U. Monin—Breech-loading fire arms.
3006 H. Griffin—Securing india rubber cylinders or rollers and blocks upon spindles and other bodies on which they are to be mounted.
3007 W. N. Hutchinson—Protecting the screw of steamers.
3008 J. A. Fullarton—Painting hoop iron, wood, and other materials.

DATED NOVEMBER 7th, 1862.

3009 M. A. F. Mennons—Paper.
3010 C. O. Heyl—Extracting and purifying fatty oils from oleaginous seeds, and extracting the agents employed from the exhausted residue.
3011 W. Clark—Utilizing refuse and azoted matters of commerce.
3012 A. V. Newton—Repeating fire-arms.
3013 T. Greenwood & J. Schofield—Mules for spinning and doubling.
3014 J. H. Johnson—Decorticating grains and seeds.

DATED NOVEMBER 8th, 1862.

3015 H. Gardner—Treating flax and other fibrous materials preparatory for manufacturing purposes.
3016 H. Kilshaw—Power looms for weaving.
3017 G. H. Ogston—Treating nitrous acid and nitric oxide in order to convert them into nitric acid.
3018 C. W. Spruyt—Rails for railways.
3019 W. Simpson—Letter boxes.
3020 G. L. Locke & J. Clark—Motive mechanism of pianofortes.
3021 E. Sonstadt—Metal magnesium.
3022 G. Kent & E. P. Griffiths—Reducing cocoa berries and other vegetable and animal substances to powder or pulp, and mashing potatoes.
3023 J. & T. Mellodew & C. W. Kesselmeyer—Looms for weaving.

DATED NOVEMBER 10th, 1862.

3024 G. H. Sanborn—Wringing machine.
3025 C. Connell—Ships or vessels.
3026 J. Whitaker—Pulping, stripping, and slicing edible roots for cattle.
3027 J. B. Lavoine—Kitchen range.
3028 S. Berrisford & W. Ainsworth—Looms for weaving.
3029 R. R. Holmes—Folding chairs and seats.
3030 R. J. Chapman—Glass and emery paper.
3031 J. Shanks—Mowing machines.
3032 W. E. Newton—Treatment of maize or Indian corn preparatory to grinding the same into flour.
3033 J. Easton & J. C. Amos—Sawing wood.
3034 T. G. Ghislin—Treatment of foreign plants and the application of the fibres derived therefrom.
3035 G. F. Lyster—Elevating or otherwise transmitting grain and other granular substances.

DATED NOVEMBER 11th, 1862.

3036 G. Davies—Crinoline skirts.
3037 W., J. & T. Booth—Rotary engines.
3038 W. Palliser—Ordnance and the projectiles to be used therewith.
3039 H. Burridge—Fire-proof buildings, and a ready method of extinguishing fires in the same.
3040 J. J. Parkes—Lever bell pulls.
3041 E. Marriott & S. Holroyd—Purification of gas.

DATED NOVEMBER 12th, 1862.

3042 W. Harper—Steam boiler and other furnaces.
3043 W. & J. Galloway—Cutting, shaping, punching, and compressing metals.
3044 G. Smith—Colouring matter.
3045 W. Dobson—Dressing lace or other fabrics.
3046 C. Socin—Looms for weaving ribbons.
3047 T. Bradford—Clothes wringer and mangler.
3048 F. J. Clowes—Rotary motion.
3049 J. Faulding—Locomotive engines.
3050 J. H. Thomson—Finishing and dressing tiles.
3051 J. A. Duntze—Communicating rotary motion to shafts or axles for various purposes.
3052 A. Graemiger—Looms.

DATED NOVEMBER 13th, 1862.

3053 A. Twaddell—Dressing or sizing warps.
3054 G. W. Rendel—Strengthening and hardening cannon.
3055 G. W. Rendel—Strengthening armour plates.
3056 T. C. & J. Eastwood—Combing wool or other fibrous substances.
3057 J. Stack—Nursery swings and cots.
3058 M. Defries—Lamps.
3059 W. E. Gedge—Machine working by compression and expansion of air.
3060 R. & P. Sykes—Rings used in machines for the continuous spinning, doubling, and twisting of wool and other fibrous materials.
3061 E. S. Ritchie—Mariner's compass.
3062 G. Davies—Preserving provisions.
3063 R. A. Brooman—Shunting trains.
3064 E. Joseph & J. Danks—Brushes, brooms, and mats.
3065 C. G. Kopisch—Propelling, steering, and ventilating vessels.

DATED NOVEMBER 14th, 1862.

3066 E. S. Cathels—Gas.
3067 E. B. Wilson—Conveying air, steam, gases, and fluids to oscillating or vibrating cylinders and vessels.
3068 W. H. Andrew—Scissors and shears.
3069 S. Roberts—Frames for containing stoppered bottles and jars.
3070 H. Morgan and J. Parkinson—Weighing machines.
3071 V. J. Cassaignes—Stereoscopes.

DATED NOVEMBER 15th, 1862.

3072 C. Binks—Treating linseed and other oils and fats.
3073 J. S. Clegg and J. Slater—Carding engines.
3074 L. Croc—Ink to be used for the purposes of electric telegraphic printing or marking.
3075 E. Kirby—Pulley for tightening the cords of window and other blinds.
3076 J. Rimmer—Hansom cabs.
3077 A. and H. Illingworth—Washing wool and other fibres.
3078 G. Sugden, J. Briggs, and J. Lockwood—Spinning wool, mohair, alpaca, and other fibres.
3079 E. H. Duru—Motive power engine.
3080 H. B. Whitburn—Material to be used in the manufacture of glass.
3081 W. H. James—Steam engines.
3082 J. Wilson—Hydraulic pumps.
3083 G. Gray—Wheels.
3084 F. Palmer—Projectiles.

DATED NOVEMBER 17th, 1862.

3085 C. Binks—Obtaining oxygen and chlorine gases.
3086 F. Rahles—Envelopes, with the view to affording better security.
3087 W. Dobson—Lace dressing frames employed in the dressing of lace or other fabrics.
3088 D. Thomson—Screw cocks.
3089 W. Williamson—Washing, wringing, and mangling machines.
3090 C. Littleboy—Implements for cultivating land.
3091 G. Richards—Ordnance and fire-arms, and the projectiles to be used therewith.

DATED NOVEMBER 18th, 1862.

3092 J. Raphael—Umbrella, parasol, sunshade, and walking sticks.
3093 J. Arbos—Generating gases for lighting and heating.
3094 P. H. Klein—Turning or shaping metals or other substances.
3095 W. H. Burnett—Working telegraphic lines, and instruments for telegraphic purposes.
3096 E. P. Houghton—Breaks for stopping or retarding railway carriages.
3097 C. W. Harrison—Looms for weaving.
3098 C. Neild and J. Hopkinson—Fire alarums and indicators of temperature.
3099 R. Brown—Warming and ventilating buildings, carriages, and ships.
3100 N. Thompson—Stopping bottles, jars, and other vessels.
3101 R. Beck—Reading glasses and magnifiers to be simultaneously used with both eyes.
3102 J. Oxley—Separating liquids from substances.

DATED NOVEMBER 19th, 1862.

3103 L. Lenzberg—Raising and lowering Venetian and other blinds.
3104 H. J. F. Marmet—Lamps.
3105 J. Chalmers—Application of iron and timber as armour for vessels of war and fortifications.
3106 R. Mushet—Cast steel.
3107 S. S. Brown—Elastic fabrics or garments.
3108 J. Arbos—Generating gases for obtaining motive power.
3109 R. A. Brooman—Tubular boilers, condensers, and superheaters.
3110 G. K., G., W., and J. Kilner—Manufacture of glass.
3111 J. B. Edmondson, J. Carson, and J. Blaylock—Printing, numbering, and dating railway and other tickets.
3112 R. Hardman—Looms for weaving.
3113 G. A. Buchholz—Manufacturing semolina and flour.

DATED NOVEMBER 20th, 1862.

3114 J. T. Hutchings—Waterproof boot and shoe soles.
3115 J. Jewsbury—Machines for raising weights.
3116 C. Stevens—Brick making machines.
3117 G. W. Oldham—Preparing and dyeing silk waste, flax, hemp, Indian or China grass, or other similar fibrous substances.
3118 F. Fletcher—Arrangement of vessels for the compression of air as applicable to lift or force pumps.
3119 R. A. Brooman—Indicating and recording the course of ships and vessels.
3120 J. W. Child—Working wool and other fibres.
3121 F. Seiler—Motive power engines and apparatus for conveying and distributing motive power.
3122 R. B. Seeley—Inkstands.
3123 J. W. Hjerpe W. Holmgren, and A. V. Sunstedt—Materials for igniting matches.
3124 W. Bottomley—Machinery for stiffening woollen and other fabrics.

DATED NOVEMBER 21st, 1862.

3125 W. Sinnock—Treatment and combination of fibrous and other materials, and the arrangement of apparatus for manufacturing same.
3126 C. Hadfield and W. A. Attkins—Compressing or dressing bricks and tiles and other materials, and machinery for such purposes.
3127 J. Townsend—Damping and preserving vegetable substances, and vegetable and other textile materials and fabrics.
3128 J. R. Napier and W. J. M. Rankine—Boilers, and valvular mechanism for steam engines.
3129 W. E. Gedge—Elastic fastening made of india rubber covered with silk or other material, and placed inside or in any other part of a glove in lieu of the fastenings hitherto used.
3130 D. Saul—Crinoline skirts, and apparatus employed therein.
3131 J. Stuart—Extracting the fibre from zostera marina and other aquatic vegetable productions.
3132 T. Walker—Utilizing sewage matters, and means employed therein.
3133 C. Wagner—Strengthening, securing, and rendering more durable the soles or bottoms of boots, shoes, and other coverings for the feet.
3134 R. W. Swinburne—Soda.
3135 G. G. Sanderson—Armour for fortifications and floating and other batteries.
3136 J. Taylor—Tiles or moulded blocks for building purposes.
3137 C. A. Orth—Apparatus for obtaining and applying motive power.
3138 S. and C. Deacon—Tops, caps, and windguards for chimneys, and apparatus for cleaning the same.
3139 A. Sutton—Time indicator for public vehicles and other uses.

DATED NOVEMBER 22nd, 1862.

3140 W. E. Gedge—Elliptical compass.
3141 W. K. Nethersole and C. Buckland—Safety signals for fire-arm practice.
3142 M. Mishores—Handles for umbrella, parasol, or other like sticks from soft canes.
3143 C. de Bergue—Manufacture of metal reeds for weaving.
3144 C. Powell—Watches and other timekeepers.
3145 W. Clark—Candle lamps.
3146 A. V. Newton—Cutting corks.
3147 J. Webster—Construction of burners and blow pipes.

DATED NOVEMBER 24th, 1862.

3148 T. J. Searle—Raising and forcing water or other fluids.
3149 J. B. Howell—Armour and other plates, and shot and shell.
3150 W. Clarke—Obtaining a vacuum or partial vacuum, as applied to the manufacture of paper.
3151 R. and W. Hawthorn—Pump valves.
3152 J. Barclay—Rollers to be used in machinery for printing textile materials and fabrics, and apparatus for drying and finishing the said materials or fabrics.
3153 J. H. Johnson—Burnishing metal surfaces, and machinery employed therein.
3154 E. Leigh—Cotton gins.
3155 W. Tatham—Preparing and spinning cotton, wool, flax, hemp, and other fibrous materials.
3156 N. J. Amies—Fabric to be employed as a substitute for elastic woven or braided webs.